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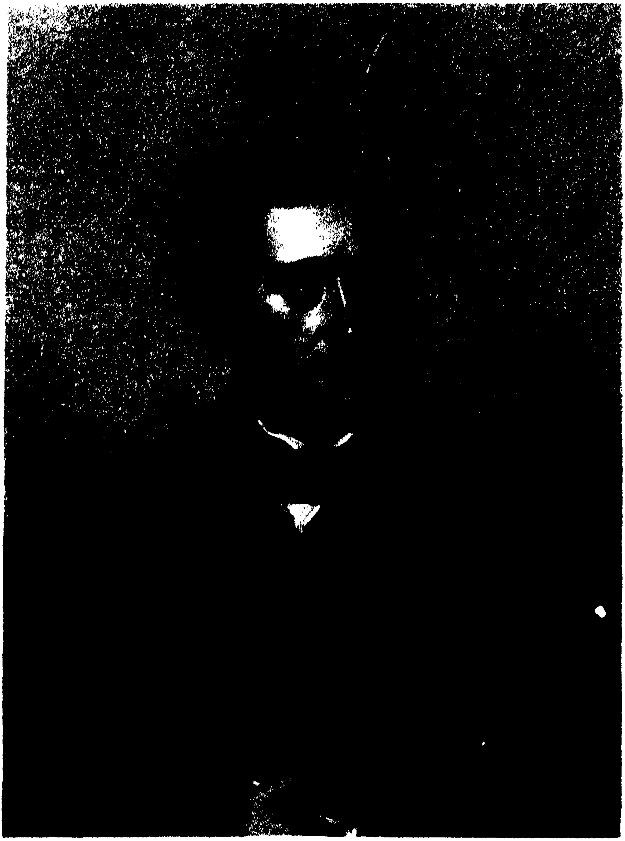

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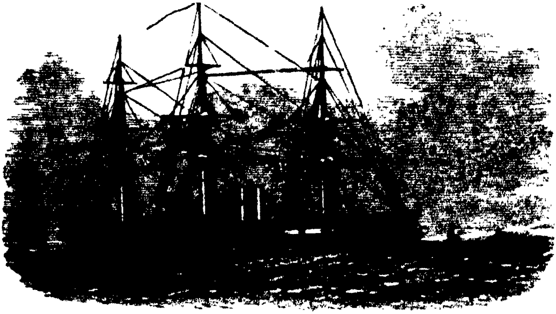

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CAPTAIN M'CLINTOCK, R.N., LL.D.,

THE DISCOVERER OF THE FATE OF SIR JOHN FRANKLIN'S EXPEDITION.

ALTHOUGH the year 1859 has been distinguished by its stupendous works of mechanical skill and construction, and by many other well-directed efforts of energy and enterprise, the most interesting event in the scientific history of the period is the discovery of authentic evidence of the fate of the Franklin Expedition. This final work has been completed by the return of the *Fox*, under the command of Captain M'Clintock, whose portrait, therefore, has been selected for the embellishment of the present *Year-Book;* the presentment of Franklin himself having already appeared in the *Year-Book* for 1850. Nearly fifteen years have, however, elapsed since the intrepid Franklin (on May 19, 1845,) sailed from the Thames with the *Erebus* and *Terror;* on the 26th of July, they were spoken in Melville Bay, by two whaling-ships, and, although some traces of the long-lost seamen were received, the solution of the terrible mystery remained to be discovered by the adventurous navigator whose portrait graces the present volume.

During the long interval, several Expeditions were sent in search of Franklin and his companions. Four were despatched by way of Behring's Straits; three proceeded overland; and twelve by the Baffin's Bay route, three of the last being fitted up at Lady Franklin's own expense. The first traces of the long-lost seamen were discovered in 1850, by Captains Ommanney and Penny; but all they learnt was that Franklin had wintered at Beechey Island in 1846. In 1854, Dr. Rae, an officer of the Hudson's Bay Company, obtained precise intelligence from some Esquimaux of the death of the explorers; and, on his return home, the Admiralty awarded 10,000*l*. to Dr. Rae for having, as they stated, "by virtue of his efforts, ascertained the fate of the Franklin Expedition." Nevertheless, the Admiralty had misgivings on the subject, for they authorized the Hudson's Bay Company to equip a small Expedition for further search, which, however, proved almost fruitless.

The public interest was far from satisfied with these results; and redoubled were the anxieties of Lady Franklin, who, on January 12th, 1856, addressed a letter to the Lords of the Admiralty, which contained this emphatic language:—

"It is my humble hope and fervent prayer that the Government of my country will themselves complete the work of searching for Sir John Franklin's Expedition which they have begun, and not leave it to a weak and helpless woman to attempt the doing that imperfectly which they themselves can do so easily and so well; yet, if need be, such is my painful resolve, God helping me. It may yet be the lot of future searchers to ascertain all, or much of what we want to know, and to bring back some journal, or some precious fragment, otherwise lost to us for ever. The best tribute that could be paid to the first and only martyrs to the great Arctic discoverers of the present century would be a national and final Expedition for this holy purpose. The objections against a useless repetition of the attempt will be unanswerable, when once an adequate effort for the attainment of these objects has been made in vain; and then may England feel that she is relieved of her responsibilities, and can close with honour one of the noblest episodes in her naval history."

A strong Memorial from eminent men of science, urging another Expedition, was addressed to the Prime Minister, Lord Palmerston, who contrived to shift the responsibility to the Admiralty, who, after a long official delay, replied to Lady Franklin that no further search would be undertaken by the Government; and seeing how they had stultified themselves by their injudicious award of the 10,000*l*. for the settlement of the question, and this being a settled official fact,—the refusal of the widow's appeal can scarcely excite surprise. Thus it was left for "the poor and helpless woman" to accomplish, as best she could, what the Government of the strongest naval country in the world had coldly, and with gross injustice, refused her!

Lady Franklin now appealed to the public, who responded nearly as coldly as their rulers: her devoted friends, it is true, came forward, but their contributions, including 500*l*. from Captain Young, of the Merchant Service, who also gave his service gratuitously, amounted only to 2981*l.*; while the Expedition which Lady Franklin, in the face of such discouragement, fitted out, cost her 10,412*l.* In procuring a ship, she was most fortunate: the Admiralty refused her the use of the *Resolute*, (with all her Arctic experiences, a large, unwieldy, and bluff-built sailing-ship,) but she purchased the *Fox*, a screw-steamer of 177 tons burthen, admirably adapted for the work, which had been originally the pleasure-yacht of Sir Richard Sutton. Lady Franklin's supporters were some of the most distinguished Arctic officers and scientific men, and the friends of Sir John Franklin, among whom were Sir Roderick Murchison, General Sabine, Captain Collinson, and many others.

To Captain M'Clintock was offered the command of the *Fox*: he had previously served with Sir J. C. Ross; in Captain Austin's Expedition; and in the third Government Expedition; to Captain M'Clintock also are principally due the results of the extraordinary journeys over the ice that have been made during the search for Franklin; and he cheerfully accepted the appointment with this manly grace and feeling:—

"I could not (he writes) but feel that if the gigantic and admirably equipped national Expeditions sent out upon precisely the same duty, and reflecting so much credit upon the Board of Admiralty, were ranked amongst the noblest efforts in the cause of humanity any nation ever engaged in, and that, if high honour was awarded to all composing those splendid Expeditions, surely this effort became still more remarkable and worthy of approbation when its means were limited to one little vessel containing but twenty-five souls, equipped and provisioned (although efficiently, yet) in a manner more according with the limited resources of a private individual than with those of the public purse. The less the means, the more arduous I felt was the achievement. The greater the risk—for the *Fox* was to be launched alone into those turbulent seas from which every other vessel had been long withdrawn—the more glorious would be the success, the more honourable even the defeat, if again defeat awaited us."

Such was the feeling of confidence in Captain M'Clintock's sincerity of purpose, his daring and determination, combined with eminent talent, and every qualification for command, that numbers sought the honour of serving with him. Among those appointed were Lieutenant (now Commander) Hobson, Captain Young (his sailing master), and Dr. Walker. The *Fox* was ready for sea on the 1st of July. Lady Franklin, who had superintended her equipment, bade her gallant captain and his officers and crew a hearty God's speed; and at Captain M'Clintock's request, placed in his hands a letter which contains the only written instructions that he could prevail upon her to give him. In this letter, Lady Franklin, having expressed her implicit confidence in Captain M'Clintock's judgment, says:—

"As to the objects of the Expedition and their relative importance, I am sure you know that the rescue of any possible survivor of the *Erebus* and *Terror* would be to me, as it would be to you, the noblest result of our efforts. To this object I wish every other to be subordinate; and next to it in importance is the recovery of the unspeakably precious documents of the Expedition, public and private, and the personal relics of my dear husband and his companions. And lastly, I trust it may be in your power to confirm, directly or inferentially, the claims of my husband's Expedition to the earliest discovery of the passage, which, if Dr. Rae's report be true (and the Government of our country has accepted and rewarded it as such), these martyrs in a noble cause achieved at their last extremity, after five long years of labour and suffering, if not at an earlier period. I am sure you will do all that man can do for the attainment of all these objects; my only fear is that you may spend yourselves too much in the effort; and you must, therefore, let me tell you how much dearer to me even than any of them is the preservation of the valuable lives of the little band of heroes who are your companions and followers. May God in his great mercy preserve you all from harm amidst the labours and perils which await you, and restore you to us in health and safety as well as honour! As to the honour I can have *no* misgiving. It will be yours as much if you fail (since you *may* fail in spite of every effort) as if you succeed; and be assured that, under *any and all circumstances whatever*, such is my unbounded confidence in you, you will possess and be entitled to the enduring gratitude of your sincere and attached friend, JANE FRANKLIN."

The following is the substance of Captain M'Clintock's narrative of his voyage, as given by him to the Royal Geographical Society, at Burlington House:—

We sailed from Aberdeen 1st of July, 1857, and bade adieu to Uppernavick, the most northern of the Danish settlements in Greenland, on the 6th of August. My object was to complete the search in the area left unexplored between the Expeditions of James Ross, Austin, and Belcher, upon the north; of Collinson and M'Clure on the west; of Rae and Anderson upon the south; whilst its eastern boundary is formed by the western shores of Boothia. The portion of the earth's surface thus defined comprises an area nearly 300 miles square. Thirty-five dogs and an Esquimaux driver were obtained in Greenland as valuable auxiliaries in our anticipated sledge travel. On the 18th of August, when attempting to pass from Melville Bay to Lancaster Sound, through vast accumulations of drift ice, the ship was seriously obstructed, and finally became beset and frozen up for the winter; then commenced an icedrift, not exceeded in length by any that I knew of. It was not until the 25th of April, 1858, by which time we had drifted down to lat. 63½°, that we were able to escape out of the ice under circumstances which will long be remembered by all on board. A heavy south-easterly gale rolled in such an ocean swell, that it broke up all the ice, and threw the masses into violent commotion, dashing them one against the other, and against the ship, in a terrific manner. We owed our escape, under Providence, to the peculiar wedge-formed bow, and steam-power of our obedient little vessel. At length, after fearful anxiety, and having drifted, during 242 days, 1385 miles, the *Fox* emerged from the pack on the 25th of April, 1858. The day of release was full of appalling dangers, and so great were the perils that Captain M'Clintock declares he can well understand how men's hair has turned grey in a few hours.

Our voyage was now commenced anew. We directed our course to the Greenland settlements for provisions, but with little success. Closely following up every movement of the ice, we crossed Melville Bay by June 18th, and reached Pond's Inlet July 27th. In company with Lieutenant Hobson, and our interpreter, Mr. Petersen, we visited the native village of Kapawroktolik, twenty-five miles up the inlet. For six days we were in communication with the friendly people: and we satisfactorily ascertained that nothing whatever respecting the Franklin Expedition had come to their knowledge, nor had any wrecks reached their shores within the last twenty or thirty years. Proceeding up Barrow Strait, we reached, on the 11th of August, Beechey Island, the scene of Franklin's first winter, and now the site of a house and store of provisions. Here is a cenotaph bearing inscriptions to the memory of those who perished in the last Government expedition, also a marble tablet to the lamented Bellot. In fitting proximity to these I placed a similar memorial appropriately inscribed to the memory of our lost countrymen in the *Erebus* and *Terror*. It was sent out for the purpose by desire of Lady Franklin. Having failed to penetrate more than twenty-five miles down Peel Sound, in consequence of the ice extending across it, we sailed for Bellot Strait, and arrived there on the 20th of August. Bellot Strait is the water communication between Prince Regent's Inlet and the Western Sea, now known as Franklin Strait; it separates the extreme northern point of the American continent from the extensive land known as North Somerset. Its shores are in many places faced with lofty granite cliffs, and some of the adjacent hills rise to 1500 or 1600 feet above the sea. The Strait was choked up with heavy masses of drift ice, and our attempts to pass through it not only failed, but were attended with great danger to the ship; but on September 6th, we sailed through, and made fast to some ice which remained fixed across the western outlet; and from thence, until September 27th, we anxiously watched every ice movement in Franklin Strait. Attempts were made to carry out provisions towards the magnetic pole, to facilitate the sledging operations in the ensuing spring, but these mostly failed. Lieutenant Hobson conducted these operations, and returned on board the *Fox* with his party in November, after much suffering from severe weather, and imminent peril on one occasion, when the ice upon which they were encamped, drifted to seaward with them across Wrotersley Inlet.

After more than eleven months' stay, early spring journeys were commenced on February 17th, 1859, when Captain Young carried a depôt of provisions across Franklin Strait, whilst I went southward, to the magnetic pole, to meet the natives, and obtain, if possible, some information. I was accompanied by the interpreter, Mr. Petersen, and some seamen; we took with us two old sledges. On the 28th of February, when near Cape Victoria, we met with a small party of natives, who readily built us a large snow hut, and spent the night in it with us. We were subsequently visited by about 45 individuals, and during the four days we remained amongst them, we obtained many relics of the lost crews, and also the information that several years ago a ship was crushed in the ice, and sunk off the north-western shore of King William's Island, but that all her people landed safely, and went away to a great river, where they died. These Boothian Esquimaux were well supplied with wood and iron, once the property of the white men. With this important information we returned to the *Fox*, after 25 days' sharp marching, and unusually severe weather, the mercury being occasionally frozen for many hours together. The result of this journey was also important to geography, since it completed the discovery of the coast line of the American continent. Early in April, our spring journeys were commenced. Lieutenant Hobson accompanied me as far as Cape Victoria, each of us having a sledge drawn by four men, and an auxiliary sledge drawn by six dogs, this being all the force we could muster. Before separating, we met two Esquimaux families in huts upon the ice; from these people we learned that a second ship had been seen off King William's Island, and that she drifted ashore in the fall of the same year. From this wreck they obtained a vast supply of wood and iron.

I now directed Lieutenant Hobson to search the northern and western shores of King William's Island for the wreck, whilst with my own party and the interpreter I marched along the east shore of King William's Island, occasionally passing elevated snow-huts, but without meeting with Esquimaux until the 8th of May, when near Cape Norton, or, as named in some charts, Cape Smith; here we found a snow village of 30 or 35 inhabitants. They quietly gathered about us, much delighted, and eager to answer Petersen's questions. They had not been apprised of our approach, and their independent testimony exactly agreed with that which had been previously obtained. Bartering commenced, when I purchased all the relics of personal interest which they possessed, such as silver spoons or forks. All the wooden articles they possessed, including a large sledge, were made of materials obtained from the wreck. Had I the means of carrying them away, I could have purchased many more things. They pointed to Peel Inlet, and told us that one day's march up it, and from thence four days overland, brought them to the wreck. None of them had been there for more than a year, and then but little remained above the ice. Their countrymen had resorted to it for several years past in great numbers, and have carried off all they could. Some few of these people had seen the white men on their march to the Great River, and said that "*many of them dropped by the way,*" but that this was not known to them at the time, nor until the following winter, when the bodies were found. Most of our information was obtained from a sharp-looking old woman, who screamed it out in answer to Petersen's questions, and was either confirmed or corrected by the listeners. I could not discover the slightest inclination to mislead us, or to hide anything they possessed from our view. The Mathieson Island of Rae was found to be a flat-topped hill, forming the south entrance of King William's Island.

Leaving these people, and pursuing the native route, we crossed the low land behind it, and met with an Esquimaux family off Point Booth. They also told us that we should find some of their people upon the large island on the Great River, alluding to Montreal Island; yet none were seen there, nor any recent traces of them. The above were the last Esquimaux we met with. Point Ogle, Montreal Island, and Barrow Inlet were successively searched, but without finding any traces of Europeans, except a few scraps of copper, tin, and iron, near an Esquimaux stone-mark. Having now overlapped the ground searched by Messrs. Anderson and Stewart when they ascended the Back River in 1855, and having no hope of meeting natives by proceeding further up it, I turned to the north-west to complete the search to the spot where our countrymen first landed upon King William's Island. It will be seen that my visit to Montreal Island was in the same time of the year, namely, the latter end of May, as that in which the survivors of the crews of the *Erebus* and *Terror* reached it; we saw it in its winter garb, as they saw it, and any marks of cairns designed by them to attract attention, would have been rendered most conspicuous by the surrounding wastes of snow. Reaching Dease and Simpson Strait, we continued the minute examination of the southern shore of King William's Island without success, until near Cape Herschel, the western limit of Simpson's discovery, when a bleached skeleton was found near the beach, around which lay fragments of European clothing. The snow was most carefully removed, and a small pocket-book containing a seaman's parchment certificate, and a few letters, were found. Judging from the remains of his dress, this unfortunate young man had been either a steward or officer's servant, and his position exactly verified the Esquimaux's assertions, that "they dropped as they walked along." The skeleton lay at full length upon a level ridge of gravel, just above the beach, in a part that was almost bare of snow; for walking on, especially if the person was fatigued, it was far preferable to the ice whereon the sledges would of necessity have to travel. Simpson's cairn on Cape Herschel was next day examined; it had been disturbed, in fact the greater part pulled down, and the impression left upon my mind is, that records were deposited by the retreating crews in this conspicuous and well-known position, but that they were subsequently removed by the Esquimaux.

I will now revert to the proceedings of Lieutenant Hobson. After separating from me at Cape Victoria, he made for Cape Felix, the north extremity of King William's Island. At a short distance to the westward of it he came upon unequivocal traces of the Franklin Expedition—a large cairn of stones, close beside which were three small tents, with blankets, old clothes, and other *débris* of a station, probably for magnetic or for shooting purposes; but although the ground beneath the cairn was broken into, and a trench dug all round it at a distance of ten feet, no record was discovered. The most interesting of the above relics, including our National Flag, were brought away. Two smaller cairns were next found by Lieutenant Hobson as he continued his search, and on the 6th of May, at Point Victory, the extreme reached by James Ross in 1830, he pitched his tent beside a large cairn, which he then supposed to be the one built by that officer. Lying amongst some stones, which had evidently fallen off the top of the cairn, was found a small tin case containing a record: in fact, the record of the long-lost Expedition. By it we have been informed that in May, 1847, all was well on board the *Erebus* and *Terror;* that in the year 1845, the same year in which they left England, they ascended Wellington Channel to latitude 77°, and returned southwards by the west of Cornwallis Island, and spent their first winter at Beechey Island. On the 12th of September, 1846, they were beset in latitude 70°05′, longitude 98°23′ W., and here, in the packed ice, about 15 miles off the N.W. shore of King William's Island, they passed their second winter. Lieutenant Gore and Mr. Des Vœux, with a party of six men, landed and deposited the above record, and another exactly similar, which was found in a small cairn one day's march further south. Round the margin of the former of these documents much additional information was given, under date the 25th of April, 1848. The ships, it states, were abandoned on the 22nd of April, 1848, about 15 miles to the N.N.W.; therefore they drifted southward only 12 or 14 miles, in twenty months. The survivors, 105 in number, under the command of Captain Crozier, landed at this spot, and built the cairn which now exists upon the site of James Ross's cairn, which must have been taken down by the Esquimaux. *Sir John Franklin died on the* 11*th of June*, 1847, and the total loss by deaths in the Expedition, up to the date of their landing, was nine officers and fifteen men. They intended proceeding on the morrow for Back's Fish River: this record was signed by Crozier, as Captain of H.M.S. *Terror*, and senior officer, also by Fitzjames, as Captain of H.M.S. *Erebus*. Even this three days' march seems to have shown them how greatly they had overrated their strength, for here they threw away a vast quantity of clothing and stores of all sorts—in fact, all that was not absolutely indispensable.

Lieutenant Hobson continued his search almost to Cape Herschel, without finding any trace of a wreck or of natives. As he retraced his steps, he left full information of his most important discoveries for me, so that I had the advantage of knowing what had already been found. After leaving Cape Herschel, and proceeding north-westward along the shore, I found the traces of natives become less numerous and less recent: and after rounding Cape Crozier—the west point of the island—they ceased altogether. When a day's march north-eastward of Cape Crozier I came upon a boat 28 feet long, mounted upon a sledge of suitable dimensions. A note left here by Hobson informed me of his having discovered her five days before. It was at once evident that this fine boat had been prepared with the greatest care for the ascent of the Back River. In order to reduce her weight she had been cut down to the thwarts, and very light fir upper works substituted, supporting a canvas weather-cloth; and she had been fitted with a housing cloth, that the crew might sleep within her, and thus obviate the necessity for carrying tents. After Hobson's party had dug out the snow which filled this boat, they found a large quantity of clothing and portions of two human skeletons. One of them lay beneath a pile of clothing in the after-part of the boat, and was probably the last survivor. The other lay in the bow, but both had been very much disturbed by wild animals. Two double-barrelled guns stood upright, and loaded as they had been placed, in readiness for use. Watches, silver forks and spoons, small religious books, and articles of all sorts were found, but neither journals nor pocket-books. Of provisions there remained chocolate and tea, but no biscuit or meat; there was also tobacco, wood-fuel, and ammunition. Now, as this boat was only sixty-five miles from the position of the ships when abandoned, it appeared to be most strange that she should have been deserted so early on the march, the more so as many precious relics, which might very easily have been carried away, remained in her. But, on a close examination, I found that she had been returning towards the ships!

After mature consideration upon all that I have seen, I am of opinion that the abandonment of the *Erebus* and *Terror* had been contemplated for months previously to its execution; also, that the whole crew had become affected by scurvy, and greatly debilitated. We know that Franklin's ships were cut off from all supplies of game for three consecutive winters, and that this is the only case on record of ships' crews subsisting solely upon their own supplies for so long a period. The *Investigator* was abandoned after the third winter, but her crew had been able to procure some valuable fresh food, game of different sorts, including about a hundred reindeer. She lost only three men, yet the whole crew were affected by scurvy. But the *Erebus* and *Terror*, before being abandoned, had lost twenty-four men, and therefore I conclude that the remainder of their crews were at least as seriously affected as were the people of the *Investigator*.

There are two important questions which have been so frequently put to me, that I gladly take this opportunity to offer some explanation upon so deeply interesting a subject. The first question is—Whether some of the one hundred and five survivors may not be living among the Esquimaux? The various families or communities of Esquimaux met with by Rae, Anderson, and myself, at different times and places, all agree in saying "No; they all died." But let us examine for ourselves. The western shore of King William's Island, along which they were compelled to travel for two-thirds of their route, is uninhabited, and all that is known to us of the mouth of the Back River is derived from the journeys of Back, Simpson, Anderson, and myself; none of us have met natives there, consequently it is fair to conclude that the Esquimaux but seldom resort to so inhospitable a locality. Even much more favoured shores in this vicinity are but very thinly sprinkled with inhabitants, and their whole time is occupied in providing a scanty subsistence for themselves. In fact, their life is spent in a struggle for existence, and depends mainly upon their skill in taking seals during the winter, a matter which requires such long training that no European has ever yet succeeded in acquiring it. It is therefore an error to suppose that where an Esquimaux can live a civilized man can live also; the probability of procuring the means of subsistence, independent of the Esquimaux, is very slight. Our sledge party, during the journey that occupied us for seventy-nine days, and covered nearly a 1000 geographical miles of distance, shot only two reindeer, one hare, seventeen willow-grouse, and three gulls. The second question is—Why have the remains of so few of our lost countrymen been found? It is, indeed, true, that only three of the 105 were discovered; but we must bear in mind that, from the time they left the ship, they were dragging sledges and boats, and therefore they must have travelled almost constantly upon the ice—not upon the land; consequently all traces or remains there vanished with the summer thaw of 1848. There is no doubt that many relics still remain strewed along the uninhabited shore of King William's Island, beneath the snow; but as it was most carefully examined three times over, I cannot think that any conspicuous object, such as would be put up to indicate where records were deposited, could possibly have escaped us. The summer at Port Kennedy proved a warm one, yet the ice did not permit us to move until the 9th of August, and the object of the expedition having been attained, we commenced our homeward voyage. On the 21st of September I arrived in London, having landed at Portsmouth, and on the 23rd the dock gates at Blackwall closed behind the *Fox*.

An interesting discussion followed on the results of the Expedition, principally as determining the fate of Franklin, and also as it bore upon the progress of geographical discovery, in which several of the experienced explorers of the Arctic regions present took part, including Sir Edward Belcher, Captain Collinson, Captain Sherard Osborn, Captain Hobson, Captain Snow, and Captain Kennedy. Captain Collinson gave it as his opinion that, after Franklin and his comrades abandoned the ships, it was almost impossible, having regard to the question of provisions, and to the probable rate at which they would be able to travel, encumbered as they were with sick, with boats, and facilities for prosecuting their journey, that they could have reached further than the bottom of the estuary of the Great Fish River, and they all perished. Captain Snow pledged his word, if health was spared to him, and whether he was assisted or not, that he would depart next spring, with the view of going over the whole ground again.

The Chairman, Sir Roderick Murchison, thanking Captain M'Clintock, observed that the gallant officer had not given half credit enough to the real merits of an Expedition the results of which were glorious in a geographical point of view; for they had proved the navigability of the Bellot Straits, and, for the first time, had pointed out the north-west point of the American continent, showing that Franklin went farther north in a ship than any other European had ever reached: in other words, that he was the first discoverer of the North-West Passage; although others (M'Clure and Collinson) were the first to make it known.

Henceforth, antarctic Cape Horn will have its *pendant*, so to speak, in arctic Cape Murchison—a name honoured alike in geographical and geological science. On this subject Captain M'Clintock writes:—"Our labours have determined the exact position of the extreme northern promontory of the continent of America. I have affixed to it the name of Murchison, after the distinguished President of the Royal Geographical Society—the strenuous advocate for this 'Further Search'—and the able champion of Lady Franklin when she needed all the support which private friendship and public spirit could bestow."

The relics, by permission of Lady Franklin, are exhibited at the United Service Museum, Whitehall. Those discovered in the boat are, generally speaking, in excellent preservation, showing how little influence the rigours of Arctic winters have upon wood or canvas. The metals are of course much rusted; but the chronometers, dip-circle, and double-frame sextant, are in excellent condition. Among the plate are several spoons and forks, six bearing Franklin's crest; and it is worthy of remark, that the greater portion bear marks of very rough treatment—some being indented, and all more or less bent. One case contains the books found in the boat. The majority are of a religious character. One Bible has many MS. notes, in a remarkable state of preservation. The fly-leaf of a small book, entitled *Christian Melodies*, has an inscription in a woman's handwriting to G. G.—probably Graham Gore, one of Sir John Franklin's lieutenants, and signed S. M. P. Another case contains a number of knives, lances, &c., obtained by barter from the Esquimaux, most of which have been evidently made by the natives from knives or cutlasses obtained from the ships. The record found at Port Victory is also exhibited. Altogether, the exhibition is of a deeply interesting though painful nature.

Captain M'Clintock's Narrative of the Discovery was published soon after his return: the great interest of the subject—for it not only reveals the fate of Franklin and his companions, but adds considerably to our knowledge of the Arctic regions, their geography, geology, and natural history—has been testified by the sale of 10,000 copies of the work; and as a literary performance it is highly creditable to the talent of the author, who, since his return, has received from the University of Dublin the honorary distinction of LL.D. The City of London have also voted him the freedom of the Corporation.

Captain Francis Leopold M'Clintock was born in 1819, at Dundalk, Ireland, of which town his father was Collector of Customs. He entered Her Majesty's Navy in 1831; was several years mate on board the *Excellent* gunnery-ship. In 1845, he obtained his Lieutenancy, upon the strong recommendation of Sir Charles Hotham, for distinguished service during the recovery of H.M.S. *Gorgon*, when stranded at Monte Video. In 1848, he joined the first Arctic Expedition in search of Sir John Franklin, as Lieutenant under Sir C. J. Ross; and served in the second Expedition, under Captain H. T. Austin, as First Lieutenant of H.M.S. *Assistance*, Captain Ommanney. He was promoted on his return to England in November, 1851, to the rank of Commander. In the spring of 1852, he sailed in command of H.M. Steamer *Intrepid*, one of the four ships under Sir Edward Belcher. He returned to England in October, 1854, when he was promoted to the rank of Captain. Having in vain solicited employment from the Admiralty, he accepted the command of Lady Franklin's final Expedition, as already described. To sum up Captain M'Clintock's services, we may add that he has spent six winters and ten summers in the Arctic regions; and has travelled on foot in search of Franklin five thousand miles—which services have been consummated by his discovery of the fate of the long-lost Explorer.

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THE
YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

IRON-CASED WAR STEAM-FRIGATES.

(See the Vignette.)

THE contract for the first of the tremendous engines of war to bear this name was accepted in the spring of 1859, by the Thames Iron Ship Building Company, and the first vessel is now building at Blackwall. This was originally intended for an iron-cased steam ram; that is to say, a vessel built as nearly shot proof as possible, and not only intended to engage, but especially to run into and sink others. From this design, however, she has been altered, and is now to be built merely as a shot-proof heavy-armed frigate of perhaps 36, or perhaps 70 guns, as the Admiralty may eventually decide. She is to be named the *Warrior*, and will be at once fire and shot proof—the largest, strongest, swiftest man-of-war afloat in the world. But since the drawings of this noble ship were made, the Admiralty have, in their more recent plans for genuine steam rams, accepted much which they had formerly condemned, and, on the other hand, condemned a good deal of work on which they formerly insisted. Thus the two iron-cased vessels, or steam-rams proper, which are now being built,—one on the Tyne by Palmer, and the other by Westwood and Bailey at Millwall,—are, though both shot proof, smaller in tonnage and armament, and nearly 100 feet shorter, than this gigantic frigate, the *Warrior*. Though great progress has been made with it, the more striking parts of the hull, such as the beak and stern, have yet to be built up. Now (Jan. 1860) one only sees dimly through the forest of timber which supports the midship part of the ponderous hull, the really enormous solidity with which it is all put together. A perfect network of T-shaped iron beams cross and recross one another in every direction. The wrought-iron "box girders" which run throughout the vessel from stem to stern are the most powerful things of their kind that have ever yet been made; yet all these beams and girders, angle-irons, and tie-rods, of which the whole hull is apparently built, are mere trifles to the things which have yet to be put into her. A whole mountain of teak, which half fills one part of the yard, has to be consumed in her outer "lining," while her armour plates lie about in ponderous slabs, weighing many tons, each from 16 to 18 feet long, 4 feet wide, and 4½ inches thick. The nose, or cutwater of the vessel is one immense slab of wrought-iron, about 30 feet long, 10 inches thick, and weighing upwards of 17 tons. The screw frame is one piece of the finest forged iron, without the slightest flaw of any kind, and weighing no less than 44 tons. Till the present work was commenced such masses of forgings were never thought of, even in the construction of the *Great Eastern* itself.

The following are the dimensions of the *Warrior* :

Extreme length, 380 feet ; ditto breadth, 58 feet ; depth, 41 feet 6 inches : and her tonnage no less than 6177 tons. The engines (screw, of course) are to be by Penn and Sons, of 1250 horse-power, and of these we shall, on a future occasion, lay a separate and detailed description before our readers. Their total weight, with boilers, will be 950 tons. For these she will, unfortunately, only be able to carry 950 tons of coal, or enough for about six days' steaming. The armament (counting her only as a 36-gun frigate), with masts and stores, will weigh 1200 tons, and this, with the hull, which is to be no less than 5700 tons, will give her a total weight, when ready for sea, of about 9000 tons in all, or the weight of the *Great Eastern* when launching. With the fine lines and immense horse-power of the *Warrior* a speed of not much less than 15 or 16 knots an hour is anticipated ; so that should her commander, in case of any emergency, choose to use her as a steam-ram, he could literally drive his ship straight over a whole fleet of three-deckers without a chance of being injured by their broadsides in closing.

There is no external keel, but an inner kind of girder, which acts as a keelson. This is formed of immense slabs of wrought scrap iron an inch and a quarter thick, and 3 feet 6 inches deep. To it are bolted the ribs—massive wrought iron T-shaped beams an inch thick, and made in joints 5 feet long by 2 deep up to 5 feet below their water-line, where the depth is diminished so as to form a deep ledge or angle, on which the armour plates and their teak lining rest. These immense ribs, except where the portholes intervene, are actually only 22 inches apart. Above the keelson, and inside the ribs, are the five box-girders we have already mentioned, which go the whole length of the ship, from stem to stern, and from which spring diagonal bands, tying every rib together. The orlop deck is of wood, and 24 feet above the keel ; the main deck is of iron, and cased with wood, and nine feet above the orlop ; the upper deck will also be of wrought iron, cased with wood, and seven feet nine inches above the main. All these decks are carried on wrought iron beams of the most powerful description, to which both decks and ribs and all are bolted as in one piece. The "skin" of the ship, as it is termed, which covers all these ribs on the outside, is also of wrought iron, an inch and a quarter thick, under the bottom, to nearly one inch thick up to the spar deck. From five feet below the water line up to the upper deck comes, in addition to this, the great armour of teak and iron over all. This is formed of a double casing of the hardest teak, 18 inches thick, with the beams laid at right-angles to one and other. Over these again come the plates of iron we have already mentioned, so as in all to case the broadside of the vessel with 20 inches of solid teak and 5 inches of the very finest wrought iron. This tremendous coat of armour, however, is, of course, not intended to cover the whole of the vessel. Indeed, with such an entire casing it could scarcely float at all. Only the broadside, or about 220 feet of the whole length, is so protected. The stem and stern have no armour plates, but are covered with iron plates 1½ inch thick, and lined with 24 inches of teak. To compensate for the armour, both the stem and stern are crossed and recrossed in every direction with water-tight compartments, so that it is almost a matter of perfect indifference to those on board the *Warrior* in action whether they get riddled with shot or not. It is, of course, needless to say that the whole vessel is subdivided in some 20 places by wrought-iron water-tight bulkheads of the most solid description. Those which cut off the stem and stern from the armour-coated portion of the ship are cased with teak and armour plates below the water-line, exactly like the broadside of the vessel. Thus, supposing it possible that both stem and stern could be shot away completely, the fighting portion of the vessel would remain as complete and as impenetrable as ever, still opposing 20 inches of teak with 5 inches of wrought iron to every shot. The bows, as the spot where the whole force of the shock must be received in case of the vessel ever being used to run down an enemy's ships of war, are strengthened inside with a perfect web of ironwork. No less than eight wrought-iron decks, an inch thick, stretch back from this part to the armour plates, as well as supports and diagonal bracings innumerable. The number of guns to be carried on the main deck is to be 36, of which 30 are under the armour coating, and the rest fore and aft. It is not yet positively decided, though we believe there is little doubt that there will be either 30 or 36 broadside guns on the upper or spar deck as well, making her a 60 or 70-gun frigate. All these pieces of ordnance are to be Armstrong's longest range guns, and throwing shot of 100lb. weight.

All the armour plates are dovetailed at the edges into one another, and fastened through the teak and iron into the inner ribs of the ship with bolts, which are counter-sunk outside so as to have their heads level with the surface of the plate. The total weight of the plates required for the vessel is 1000 tons.

These monstrous slabs of armour are formed of scrap-iron with a certain proportion of puddled bar-iron, which makes a mixture of almost unyielding toughness. Some of them taken to Portsmouth have been subjected to the most severe tests in order to ascertain their capacity for resisting shot and shell, and the remnants of these plates are now at the works at Blackwall. They were fired at by 68-pounders at a point-blank range of 200 yards. The massive shot even at this short distance have failed to penetrate the iron, though they have dinted it to the depth of one and a half or in some cases two inches. Six of the shots struck within a circle of almost less than two feet diameter. Each after the second shot (which, of course, more or less broke the fibre of the iron) tore a narrow circular fissure or crack outside the mark of the diameter of the shot dint, until at the sixth shot in almost the same place the plate was broken and torn apart. Six such heavy shots are never likely to strike all in the same spot; and the *Warrior* will herself be armed with the heaviest guns in the world, which have sufficient range to enable her to commence her action with an enemy at least four miles distant. At two miles she herself will be to the enemy out of range for all practical purposes, even for the heaviest smooth-bore guns yet used in any navy, and at 1000 yards distance a 68-pounder shot scarcely dints her iron sides to the depth of half an inch.—*Times.*

PROGRESS OF CIVIL ENGINEERING.

MR. GEORGE PARKER BIDDER, as President of the Institution of Civil Engineers, has delivered an address, the main objects of which present many points of high interest. Among these are the following:—

Hydraulic Engineering.—Mr. Bidder urged the importance of the effects of under-draining upon the condition of our rivers; and reverted to his view—that in certain soils and under certain circumstances, the effect of under-draining would be to pass less water to the rivers than had previously flowed into them. If this view be correct, precautions should be taken to provide for the possible effects of an operation which is, otherwise, so rapidly augmenting the fertility of our soil. The prevailing fashion of subverting the cesspool system and of introducing outfall sewers, was then adverted to. One great inducement hitherto held out, had been the prospect entertained of employing the sewage for the fertilization of the neighbouring land. Mainly by the exertions of Mr. Hawkesley, C.E., this has been proved a delusion, and to a great extent dispelled. Recent investigations have shown, that in towns amply supplied with water, the sewage contains very little, if any, fertilizing quality; certainly none of commercial value. Indeed, a careful consideration of the economy of our rivers might have anticipated the conclusion. Look at the course of the Thames flowing through this great city—consider the enormous population on its banks, before it reaches the metropolis—what would have been its condition, had not running waters possessed that quality of self-purification which renders the sewage of towns of no practical value? The President announced his intention to devote 40*l.* for the best paper upon the "Regime of Rivers."

Submarine Telegraph Cables.—The experience, up to the present time, has altogether been very unsatisfactory—whether we consider the condition of the cables laid across the Atlantic, or of several of those submerged in the Mediterranean, and as regards their duration after being laid down. It was the opinion of the late Mr. R. Stephenson, whilst presiding over the affairs of the Electric and International Telegraph Company, that a cable could not be anticipated to last more than ten years, and he therefore insisted on an annual provision being made for this decay. On the other hand, there are other companies possessing submarine cables, who will not make any such provision. On this subject the Government have appointed a Commission to investigate this question, with the most ample scope for their inquiries. The inquiry has for its object, not only the best form of cable to be laid at great depths in the ocean, but also the electrical condition when laid. It is, no doubt, owing to the want of such a preliminary inquiry, that so large an amount of national capital has been wasted in such operations, and especially in laying that across the Atlantic.

Westminster and Victoria Bridges.—In conclusion, Mr. Bidder thus effectively contrasts the progress of Government works with those undertaken by private enterprise:—There is, within a short distance, an iron bridge, scarcely even partly completed, across the River Thames. There is no doubt that this bridge will be substantially and skilfully constructed, but it cannot be said to involve any feature of mechanical difficulty; it is constructed in London, and thus commands, in respect of labour and materials, the resources of the whole empire. Another iron bridge, spanning the River St. Lawrence, in Canada, is entirely completed, and is opened for traffic; this bridge extends for nearly a mile and a half across a stream, having a current varying from seven to ten miles an hour; it has to resist the pressure of ice accumulating, occasionally, to the depth of thirty or forty feet. The severity of the climate is such as to restrict the actual period of working to a few months in each year; the iron work and the great proportion of the skilled labour was derived from England; and a severe monetary crisis had also to be surmounted, which latter, however comparatively unimportant in Government operations, exercises a formidable influence on private enterprise. Yet this entire work has been executed contemporaneously with the one uncompleted half of Westminster Bridge; thus evidencing what the civil engineer can do when impelled by the pressure of private enterprise, as contrasted with his exertions when trammelled by the restrictions incidental to the conduct of Government works.

THE GREAT BELL OF THE WESTMINSTER PALACE CLOCK.

IN the *Year-Book of Facts*, pp. 86—89, 1859, were fully described the raising and hanging of the Great Bell in the Clock-tower at the New Palace, Westminster; and Mr. Jabez James has since read to the Institution of Civil Engineers a paper on the process, with some account of the four quarter bells. These were cast by the founders of the Great Bell, Messrs. Warner; the third having been condemned as defective, had to be recast. The first, weighing rather more than 1 ton 1 cwt., was lifted in three hours; the second, weighing upwards of 1 ton 5 cwt., occupied three hours and a half; the third, which weighed above 1 ton 13¼ cwt., took four hours. These three bells were raised by means of a single chain, made of bars 7-8ths of an inch diameter, and a crab with a double purchase. The fourth quarter bell, weighing more than 3 tons 17¼ cwt., was lifted in six hours by a similar chain, reeved through a single pulley, and by a double purchase-crab. These bells were hung at the four angles of the tower, around the large bell, for convenience of sounding. In conclusion, Mr. James proceeded to state the experiments that had been made before the weight of the hammer and the distance it should fall through were finally settled. The weight was decided to be 6 cwt. 3 qrs. 10 lbs., with a fall of thirteen inches. This arrangement for striking the hours was continued until (on October 9th) the bell was discovered to be fractured in two places. One of the cracks was precisely in the same position in this bell as in the former one, exactly opposite to the place where it was struck by the hammer, and the other was about two feet away from it. The first fracture appeared to be about fifteen inches, and the second about twenty-four inches long; but they did not extend through the thickness of the metal, nor within two or three inches of the lip.

In the discussion, it was remarked, that the composition of the metal of the bell was not the same as that usually adopted in this country and on the Continent, there being a greater proportion of tin than was customary. It was also thought that the use of charcoal-smelted copper, as was the case in Russia, was advantageous. It was suggested whether the interval between the blows of the hammer might not have been too short, and whether the chattering of the hammer, due to its not being cleared immediately after striking, might not have a tendency to produce numbness, and hence stun the bell and contribute to its fracture. It was urged that the great weight and fall given to the hammer must have acted prejudicially. These were supposed to be rendered necessary by the thickness of the metal, which had been made considerable, in order to guard against accident; but it was contended that it had a contrary tendency.

THE "GREAT EASTERN" STEAM-SHIP.

THIS stupendous vessel has occupied a large share of public interest during the past year.* She started on her trial trip on September 7th; on the voyage an explosion took place off Hastings, owing to some imperfection or neglect in connexion with the casing of one of the boilers, when ten firemen were killed, and several other persons were severely injured. The effect of the catastrophe is thus described:

> The engineers who inspected the rent masses of iron and other evidences of the tremendous force of the explosion came to different conclusions as to the amount of steam pressure which occasioned it. The majority generally estimated it as having been between 400 lb. and 500 lb. to the square inch, an amount of pressure which, as far as can be calculated, has never yet been got by steam. The highest-pressure boilers for locomotives are only made to withstand about 150lb. to the inch. Even for experimental purposes a pressure of 500 lb. or 600 lb. steam has never yet been generated. James Watt, in his earliest experiments on evaporation, made some very small globular boilers on which it was said a pressure of 400 lb. was eventually got, but anything approaching to 500 lb. or 600 lb. has never been so much as heard of among engineers till the present most unfortunate occurrence. Gunpowder when exploded expands 800 times its bulk, and when steam is super-heated to an intense degree the water becomes utterly decomposed into its constituent gases, oxygen and hydrogen, which, when brought into contact with any red-hot surface, recombine with the most fearful explosion. This was exactly what took place on board the [illegible], and the blow-up in its force was precisely similar to what would have taken place had the space between the inner and outer casing of the funnel been filled with gunpowder instead of steam.

The above trial and subsequent trips have been minutely detailed in the daily journals. In that from Portland to Holyhead, in October, the vast size and speed of the engines are illustrated by the fact, that at ten revolutions the paddle-wheels dashed through the water at something like 1600 feet per minute, and the screw revolved at 2500. When accomplishing this, the consumption of fuel was at the rate of 250 tons a day for both engines, the indicated power being nearly 5000 horses—about 2000 horses for the paddles and a little over 3500 for the screw. Nevertheless, the trial trips have been imperfect successes. Mr. Bidder, as President of the Institution of Civil Engineers, thus feelingly referred to the vessel as the *opus maximum* of Brunel:—"There does not appear to be any reason why she should not be mechanically successful; but all who have had extended experience in our profession are aware, that in all experiments there will arise certain phenomena, which no human foresight can anticipate. Now, seeing that the *Great Eastern* is six or seven times the bulk of any existing vessel, and seeing that this, of necessity, involved the application of two sets of engines, two kinds of motive power—the paddles and the screw-propeller—bearing also in mind, that she was intended to encounter head seas at a speed never hitherto contemplated, and knowing also the enormous forces which ordinary vessels have to withstand in heading the waves, however slowly in heavy weather, it might reasonably be expected, that in many respects her first trial would be somewhat disappointing. I sincerely hope, and I am sure that I carry your sympathies with me, in trusting, that there still remain in this country, sufficient skill, enterprise, and co-operative action, to bring this great experiment to a real test, and thus to complete the most fitting memorial to the fame of our deceased friend."

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* Very fully described in the *Year-Book of Facts*, 1858.

SUPER-HEATED STEAM.

THE idea of working engines by Super-heated Steam, and the immense saving of fuel and increase of power it would effect, was, we believe, first started many years ago by Mr. Howard, and subsequently by Dr. Haycraft. The difficulties, however, in the way of its adoption at that time, and the undue estimate of the importance of the principle, prevented those gentlemen from realizing very great practical results. At a later period the matter was again taken up by an American engineer—Mr. Weatherhead—who, however, only super-heated a portion of the steam and mixed it with common steam in its way to the cylinders. The success which attended even this partial application of the process again revived the idea, and encouraged other engineers to turn their attention to the subject. The result of these renewed efforts is that several methods of securing the great economy to be effected by super-heating the steam have been under trial. The value of the improvement on the score of economy in working may be best illustrated by a single fact, namely, that the Peninsular and Oriental Company's bill for coal annually amounts to the enormous sum of 700,000*l.*; and that by working their vessels with super-heated steam properly applied, it is become almost certain that, without any detriment to the machinery, from 28 to 30 per cent. of this gigantic outlay can be saved. As to the various proposed methods of super-heating steam, it may be briefly explained that the conditions required to be fulfilled are perfect simplicity of arrangement with ready control over the apparatus; that it should be so placed as not to be liable to accidental injury in the engine-room; and that the heat employed for super-heating the steam should be waste heat which has already done its duty in the boilers and is passing away.

All these conditions have been most satisfactorily fulfilled by Mr. Penn in the new engines on board the Peninsular and Oriental Company's ship *Valetta,* which were tried down the Thames for the first time on April 21st. The *Valetta* was for many years the mail-boat between Marseilles, Malta, and Constantinople. While thus employed she had Penn's engines of 400 horse-power, and to work these up to an average speed of fifteen miles an hour required a consumption of fuel of from 70 to 75 tons of coal per day. At no time was it less than from 45 to 55 tons. These engines have now been removed to a vessel nearly double the tonnage of the *Valetta,* and the latter fitted with engines by Mr. Penn on the super-heating principle. His method of doing this is to place in the smoke-box of the boiler, through which the hot air from the furnace first passes, as large a number of small pipes as is consistent with allowing a free draught from the furnaces. Through these all the steam from the boilers passes in its way to the cylinders. By this plan an immense heating surface in the pipes is secured; the steam is in a subdivided form, so as to be readily acted on; and the waste heat from the furnace is utilized at the point where its intensity is greatest, and where the greatest conveniences exist for applying the apparatus. By means of three ordinary stop-valves the whole contrivance can be shut in or off from the engines at pleasure. In ordinary engines steam leaves the boilers at about 250°, but declines from this temperature in its way to the engines to 230°, undergoing from condensation a still greater and more serious diminution of heat in the cylinders. From these causes, and also from the immense quantity of waste heat which escapes through the smoke-box and up the funnels, there has always been a theoretical loss of steam power amounting to 40 per cent., as compared with the coal consumed. It is this loss of power and waste of heat which the super-heating process is intended to prevent; and which will, of course, allow a reduction of from 28 to 30 per cent. on the fuel now consumed.

By the super-heating process the steam is raised in passing along the pipes in the smoke-box (where the heat is about 650°) from a temperature of 250° to 350°, and so enters the cylinders at 100° in excess of the temperature due to its pressure. This extra heat is, of course, rapidly communicated to the metals, and prevents the condensation in the cylinders or other parts of the engines, which would otherwise, of course, take place. Singularly enough, a smaller amount of cold water is required to condense the steam at this high temperature of 350° than when at the ordinary heat of common steam. The trial trip of the *Valetta* was most satisfactory, not only as regards the engines, but still more so as to the application for the super-heating process. At the measured mile at the Lower Hope, near the Nore, the result of repeated runs gave an average speed of nearly 14½ knots per hour, thus realizing with engines of 260 horse-power, and a small consumption of fuel, the same rate of speed as had been gained with her previous engines of 400 horse-power, and a consumption of 75 tons of coals per day. The super-heating apparatus evidently effected a most important saving in fuel, but until an average of many days' working was obtained it was difficult to estimate the exact amount economized. There seems, however, every reason to believe that an average of 14 knots an hour can be obtained with a consumption of only from 24 to 26 tons per diem. The thermometer during the trial indicated in the steam pipes an addition to the ordinary temperature of 100°, which Mr. Penn believes to be enough for all practical purposes of super-heating. Even when making from 33 to 34 revolutions per minute, and driving the vessel against a strong head wind and tide, it was impossible to consume all the steam generated, which was blowing off from both boilers all the trip. The engines are remarkable for the extraordinary beauty and simplicity of their proportions, qualities well known in all engines from Penn and Sons, and which, combined with the strength of the materials and perfection of the workmanship, make this firm the foremost in the world for machinery of this description. Both cylinders are oscillating, of 62 inches diameter, and with a stroke of 4 feet 6 inches. The paddles are on the feathering principle, and the boilers of Lamb and Co.'s patent. During the whole course of the trials, and when going at one time nearly 16 knots, there was no perceptible vibration, even at the end of the saloon nearest to the engines. When it is remembered that the super-heating process which can effect such important results is capable, as we have said, of application to steam machinery of every kind, including even locomotives, it cannot be doubted that the trial of April 21st, and its great success, is one of the most important events for the progress of steam which we have had to chronicle for many years.—*Times.*

Upon this communication, the Hon. Major Fitzmaurice writes to the same journal:—

"It is now twelve years or more since I was engaged in experiments at Woolwich Dockyard, introducing high-pressure engines for ships, launches, and gunboats, and I then endeavoured to introduce super-heated steam, in order to reduce the size and weight of boilers in small boats.

"I was laughed at by several eminent engineers for endeavouring 'to roast the steam after it had been boiled' (for that is literally the process), by introducing coils of pipe into the smoke-box; and I have the identical drawings by me at this moment. My principle was, that the lateral heat of a flame is nothing as compared with that at the point, and that the great mass of caloric always runs in the direction of the flame. I believe, for this reason, the extraordinary fact has often been seen, that, when two men are walking together in a thunderstorm, one is killed while the other is only severely scorched. The point of the flame has entered one, while the other has only felt the lateral rays. Having spent many thousands in the advancement of science, all I ask for is credit where it is due."

JONSON'S MARINE-ENGINE GOVERNOR.

A PAPER has been read to the Institution of Mechanical Engineers by Mr. Maudslay, upon this invention, to prevent the engine from running off at an excessive speed, when the resistance of the water to the screw-propeller or paddle-wheel is suddenly removed by the pitching or rolling motion of the vessel in stormy weather. The Governor consists of a piston working in a cylinder, the bottom of which communicates with an opening through the side of the vessel, as near as possible to the propeller or paddle-wheel; the pressure of water in the bottom of the cylinder thus corresponds exactly with the depth of immersion of the propeller, and tends to raise the piston, which is loaded on the top by an adjustable spring, and connected by bell-crank levers and links with a throttle-valve in the steam pipe of the engine. When the motion of the vessel causes the propeller to be less deeply immersed, the pressure of water in the cylinder is diminished, and the piston is forced down by the spring above, closing the throttle-valve to the required extent, and preventing the speed of the engine from increasing; while, on the other hand, when the propeller is more deeply immersed, the pressure in the cylinder is increased, and raises the piston, opening the throttle-valve and admitting more steam to the engine, so as to maintain the required speed; the object being to control the speed of the engine before it has time to change sensibly instead of waiting for a change of speed in the engine to bring the governor into action, as in the case of the ordinary engine governor.

DENSITY OF STEAM.

Mr. W. Fairbairn has communicated to the British Association, his "Experimental Researches to determine the Density of Steam at various Temperatures." The object of these experiments was to verify or correct the theoretical formulæ and speculations in regard to the relation between the specific volume and temperature of steam. The experiments were conducted on a novel and original principle, applicable to any temperatures and pressures capable of being sustained by glass vessels. The determinations were made at pressures varying from ten to fifty atmospheres. They uniformly show a decided deviation from the law for perfect gases, and in the direction anticipated by Professor Thomson, the density being uniformly greater than that indicated by the theoretical formula of Gay-Lussac or Dalton, Dumas, and others. The author hopes at the next meeting of the Association to lay before the Section results which will determine the value of super-heated steam, its density and volume, as compared with the pressure, at all pressures varying from that of the atmosphere to 500 pounds on the square inch. Professor Macquorne-Rankine and Dr. Joule expressed their opinion of the great value of Mr. Fairbairn's researches, and trusted that he would continue them.

SURFACE CONDENSATION.

Dr. Joule has communicated to the British Association his researches "On Surface Condensation." The author described the experiments he had made on this important subject. A peculiar arrangement he had introduced gave a very increased effect to a given surface. In this arrangement a copper spiral was placed in the water spaces. The spiral had the effect of giving the water a rotatory motion, which was thus compelled to travel over a larger surface than it would otherwise. He also pointed out that he had succeeded in producing a better vacuum than the temperature of the condensing and condensed water appeared to warrant, and that thus a fresh and unexpected advantage was proved to belong to the system of surface condensation.

A discussion took place, in which Professor Macquorne-Rankine, Messrs. A. Taylor and W. Smith, took part; and a wish was expressed that Dr. Joule would continue his important researches and give the results at a future meeting.

STEAM TRANSPORT, AND THE CONSUMPTION OF COAL.

A **paper** has been read to the British Association "On Mercantile Steam Transport Economy as effected by the Consumption of Coal," by Mr. C. Atherton, Chief Engineer of the Royal Dockyard, Woolwich.—This is the third and concluding paper on this subject.

Mr. T. Webster pointed out that in Mr. Atherton's first paper on this subject he had taken the consumption of coal in marine engines at 4 lb. per indicated horse-power per mile, while in his present paper it was taken as low as 2½ lb. This was a gratifying fact, showing the progress which had been made. He believed it was due mainly to the use of super-heated steam and the increased adoption of the principle of expansion. He thought the public were indebted to Mr. Atherton for his labours, which he trusted would result in the establishment of a unit of displacement and horse-power, in lieu of the tonnage measurement at present adopted. Mr. W. Fairbairn bore testimony to the great value of Mr. Atherton's labours; he recollected when from 7 lb. to 10 lb. per indicated horse-power was the general rate; that had been reduced to 4 lb., and it was now from 2 lb. to 2½ lb. Super-heated steam had doubtless been the cause of this economy. Mr. M'Connell considered that super-heated steam was in reality dry steam.

STEAM SUPERSEDED.

DR. A. H. ENSMAN, of Stettin, proposes, as a Substitute for Steam, carbonic acid in the solid form, and anticipates that his discovery (?) will lead to the navigation of the atmosphere with balloons. It is nearly a quarter of a century since Thilorier succeeded in producing solid carbonic acid; and the process of making it has since been much simplified by Faraday and Natterer. Faraday has stated that carbonic acid is a singular substance, on account of the high pressure which emanates from it in passing from the solid state; there is nothing equal to it in this respect. Its vapour is said to have an enormous pressure which increases with its temperature. At Zero, it is equal to 23 atmospheres; at 16 degrees, to 29 atmospheres; and at 32 degrees, to 38 atmospheres. The only difficulty was the production of the solid acid in sufficient quantities; but Natterer has succeeded in obtaining several pounds at once, and his apparatus, which will stand a pressure of 2000 atmospheres, is now sold in Vienna for 10*l.* We are not told the cost per pound of the acid, nor its economy as compared with steam.

STEAM-BOILER EXPLOSIONS.

MR. T. ARCHER, JUN., has patented certain improvements in apparatus for preventing Explosions of Steam-boilers. Here the supply valve is enclosed in a case having an opening at the top, through which the rod of the safety-valve passes; and by which steam passes from the boiler when the safety-valve is somewhat raised. On the rod of the safety-valve there is another valve, which, when the safety-valve is raised beyond a certain point, closes the opening in the top of the case, causes the steam to pass through a pipe which leads from the case to the interior of the furnace of the boiler, and so damps the fire and reduces the pressure on the boiler. Steam is also caused to pass on to the fuel in the furnace when the water in the boiler gets too low. This is accomplished by a float in the boiler having a rod attached to it, which passes through a stuffing-box in the top of the boiler. This rod also passes through a hole in a prolongation of the weighted roller, which keeps down the safety-valve, and on the end of the rod there is an enlargement which cannot pass through the hole in the lever. Thus, when the water in the boiler gets too low, the weight of the float depresses the arm of the lever through which the rod passes, lifts the arm of the lever which keeps down the safety-valve, and allows the steam to pass on to the fuel in the furnace.—*Mechanics' Magazine.*

IMPROVEMENTS IN STEAM NAVIGATION.—CONSUMPTION OF SMOKE.

THE following noteworthy facts have been stated to the Mechanical Section of the British Association.

Mr. J. Oldham referred to the use of Silver's Marine Governor for steam-engines on board ships, which are stated to be so sensitive in their action that the slightest pitching motion is at once indicated, and the steam admitted or excluded as the case may require.

Mr. A. Henderson, in reference to Silver's steam governor, which had been mentioned by Mr. Oldham, said he believed it to be a most valuable invention, and in connexion with Luntley's steering apparatus, which had been fitted to the *Great Eastern*, would place the control of a steam-ship directly in the hands of the captain.

Mr. Oldham, in reply to a question from Mr. Eddison, stated that there was a decided economy in fuel arising from the consumption of smoke, but even if there were not, it was worth all the trouble to get rid of the dense clouds of smoke at sea, which frequently led to collisions, and were worse than fogs.

Mr. W. Fairbairn had paid great attention, for many years past, to the subject of smoke consumption. The principles on which this depended were now well known, and there were an infinite number of contrivances by which the object could be attained, but in all cases their efficiency depended on the care of the stokers. He believed that it must be made the interest of the stokers to get rid of the smoke: let there be premiums for them when there was no smoke, and fines when smoke was made; and he saw no difficulty in getting rid of the nuisance entirely. With reference to Silver's governor, it was an extremely ingenious invention, and he had no doubt of its efficiency and its value on board ship. On land there was nothing equal to the revolving valves originally invented by Watt, but these were not applicable to marine engines.

Mr. Oldham, in reply to a question from Admiral Moorsom, in reference to Griffith's screw-propeller, said that so far as his experience went there was nothing equal to Smith's original propeller in form, though a third thread was now used which increased its efficiency.

Mr. W. Smith pointed out that, looking to the experiments which had been made on board H.M. Yacht, the *Victoria and Albert*, and lately on board H.M.S. *Doris*, Griffith's screw had proved to be the best. Silver's governor was now on trial in forty ships. It saved the engineer's special attention to the throttle-valve when a heavy sea was running. Frequently in such cases, at present, the engineer, to avoid the incessant watching of one valve, often shut off half steam, which, though it insured safety, was a considerable loss in point of economy. The space required for one of these governors was 3 ft. by 2 ft. 6 in. The number of revolutions of the momentum was about 130 to 140 per minute.

Mr. T. Webster remarked on the great progress that had been made during the last twenty years with regard to the prevention of smoke. This showed the value of such discussions as these at meetings of the British Association. He called attention to the fact, that at the time when the Act for the metropolis was passed, the potteries were specially exempted from its operation, it being then asserted that it was impossible. Such, however, had been the progress of science, that the difficulty had been so far overcome and the exemption had been repealed; and pottery kilns were now subject to the same penalties as other furnaces. The prevention was effected by applying the same principles which had been applied in the other cases. These principles had been well laid down and explained by Mr. C. W. Williams, in the Essay which had gained the prize at the Society of Arts.

NEW IRON STEAM BATTERIES.

THE Admiralty have in course of construction four Iron Steam Batteries, or Steam Frigates. They are to be cased with iron of the same thickness (4½ inches) as that used in the old floating batteries, but the vessels, when completed, will sit more lightly on the water, and will be far more elegant in appearance, and, in fact, will be hardly distinguishable from an ordinary frigate. They will have great beam, nearly equal to that of the *Great Eastern*. Their superior lightness over the old floating battery will be due to their being only partially covered with plates, which will be confined to the sides of the vessel above and for a short distance below the water-line, and neither the head nor the stern of the vessel will be covered. The head will be fitted with a false bow or sheathing to conceal her real purpose, that of running down hostile vessels, but after her first encounter with an enemy, this false bow will be broken, and will fall off.

The tonnage of each vessel is 3668 tons, builders' measurement, and each will cost from 157,724*l.* to 161,392*l.* This, it must be remembered, is for the mere hull of the boat; and as her equipment will necessarily be very expensive, and her engines of immense power, we shall take a low estimate of the cost when we assume that each vessel will, when ready for sea, cost about a third of a million of money. These, however, are only the smaller steam batteries; those already building of 6000 tons will cost upwards of a quarter of a million, or 264,000*l.*, for the hull alone, and when fitted for sea will not cost less than half a million of money each.—*Steam Shipping Gazette.*

THE NEW SCREW LINE-OF-BATTLE SHIP, VICTORIA.

THIS magnificent ship, which was launched last summer, from Portsmouth yard, in the presence of Her Majesty and the Royal family, deserves particular notice as being larger than any line-of-battle ship now afloat, and also as being the first three-decker that has been designed expressly as a screw-steamer. Her actual displacement when at her load-line will amount to very nearly 7000 tons, which is greater than that of every other ship of war by nearly 1000 tons!

We have at present afloat five screw three-deckers—the *Marlborough*, *Royal Sovereign*, *Duke of Wellington*, *Royal Albert*, and *Royal George*. These were originally designed for sailing ships; the first three by the late Surveyor of the Navy, Sir William Symonds; the *Royal Albert* by the late Mr. Oliver Lang. The *Royal George* was built on the lines of the old *Caledonia*, and was launched at Chatham in 1827. To adapt these vessels for the reception of the screw, they were altered as follows:—The *Marlborough* was lengthened in midships and at each end, and was also increased slightly in breadth; the *Duke of Wellington* and *Royal Sovereign* were lengthened in midships and by the stern; the *Royal Albert* was lengthened by the stern; and the *Royal George* only had the screw aperture cut in her deadwood, and was not lengthened at all.

The following table shows the comparative principal dimensions of these ships and of the *Victoria*.

Name.	Guns.	Horse Power.	Length between Perpendic.		Extreme Breadth.		Depth in Hold.		Burthen in Tons.
			ft.	in.	ft.	in.	ft.	in.	
Royal George . . .	102	400	205	7	54	6¼	23	2	2616
Royal Albert	121	500	232	9	61	0	24	3	3726
Duke of Wellington .	131	700	240	6	60	1	24	8	3771
Royal Sovereign . .	131	800	240	6	60	0	24	8	3759
Marlborough	131	800	245	6	61	2¼	25	10	4000
Victoria	121	1000	260	0	60	0	26	10	4112

It will be observed that the *Victoria*, though larger than the *Marlborough*, does not carry so many guns. The armament of the *Victoria* is, however, the heavier of the two, as she carries on the middle and lower decks nothing but 68-pounders, as will be seen by the following table:—

	Ins.	Cwt.	Feet.		No.
Lower Deck	8	65 ...	9	0	
Middle Deck	8	65 ...	9	0	30
Main Deck	32 prs. ...	56 ...	9	6	32
Upper Deck	32 prs. ...	42 ...	8	0	26
Do. do.	68 pr. pivot	95 ...	10	0	1
		Total			121

The engines of the *Victoria* are by Messrs. Maudslay, Sons, and Field, and are of the nominal power of 1000 horses.—*Mechanics' Magazine.*

We may here direct attention to an able series of papers on Shipbuilding, in the *Mechanics' Magazine* for the past year, by Mr. E. J. Reed, one of the editors of that journal.

NEW IRON STEAM RAM.

Of the invention of the Steam Ram, we gave some details in the *Year-book of Facts*, 1859, pp. 31, 32; and we have now to report the progress of a gigantic work of this class. The English Government have building a wrought-iron vessel of immense size, strength, and steam power, specially adapted as a vessel of war, and for running down ships of the largest kind, not even excepting the *Great Eastern* itself. The contract for this tremendous engine of modern war has been taken by the Thames Iron Shipbuilding Company, and sufficient progress has been made with the ironwork to be used in her, to make it certain that she will be afloat and fitting for sea by June next. Her dimensions will be—extreme length, 380 feet; breadth, 58 feet; depth, 41 feet 6 inches; and her tonnage no less than 6177 tons. The weight of the empty hull will be 5700 tons. The engines are to be by Penn and Sons, of 1250-horse power, and of these we shall give a description on another occasion. Their weight with boilers will be 950 tons; she will carry 950 tons of coal, and her armament, masts, stores, &c., will amount to 1100 tons more. Thus, at sea her total weight will be about 9000 tons, which will be driven, when so wanted, through the water against an enemy's ship at the rate of 16 miles an hour. It is difficult by mere description to give an adequate idea of the tremendous strength with which this vessel is to be built. The keel, or rather the portion to which the ribs are bolted, is made of immense slabs of wrought scrap iron, an inch and a quarter thick, and three feet six inches deep. From this spring the ribs—massive wrought iron T-shaped beams, which are made in joints about five feet long by two deep, up to where the armour-plates begin, five feet below the water-line. These beams are only 3 feet 8 inches apart, while, for a distance of 10 feet on each side of the keel, they are bolted in at only half this distance asunder. Five feet below the water-line the armour-plates commence, and, to give room for these, the depth of the rib diminishes to about half, or nine inches. Over the ribs, and crossing transversely, are bolted beams of teak a foot and a half thick, and outside these again come the armour-plates. Each of these plates is to be 15 feet long by 4 feet broad and 4½ inches thick. Several of them have been made by the company of puddled iron, of annealed scrap iron, and of scrap iron unannealed; and experiments are now being made at Portsmouth with a view of testing practically which best withstands the tremendous attack of 68-pounders. It is almost needless to say, that each plate is the very perfection of material and manufacture. These ponderous slabs go up to the level of the upper deck. The orlop deck will be of wood, and 24 feet above the keel. The main deck will be of iron, cased with wood, and 9 feet above the orlop. The upper deck will also be of wrought iron, and 7 feet 9 inches above the main.

All the decks are carried on wrought-iron beams of the most powerful description, to which both the ribs and iron decks are bolted; while along the whole length of the vessel, from stem to stern, are immensely solid wrought-iron beams at intervals of five feet inside the ribs, which are again crossed by diagonal bands, tying the whole together in a perfect network. The armour-plates are not intended to shield the whole vessel, only the fighting portion, about 220 feet of the broadside, being thus protected. This broadside, however, will mount 14 of the Armstrong 100lb. guns, which, with two broadside guns on the upper deck and two pivot guns of the same kind forward and two aft, will give her a total armament of 36 guns, each throwing a 100lb. shot over a range of nearly six miles. Neither the bows nor stern have any of the large armour-plates, but are coated with wrought-iron plates of nearly one inch and a half thick over two feet of teak, which will offer sufficient resistance to prevent most shots from going through. But to compensate for this apparent deficiency, both bows and stern are so crossed and recrossed in every direction with water-tight compartments, that it is a matter of perfect indifference whether they get riddled or not; and each of these ends is shut off from the engine-room and fighting portion of the ship by continuous massive wrought-iron transverse bulkheads. So that, supposing it possible that both stem and stern could be shot away, the centre of the vessel would remain complete and impenetrable as ever, still offering in all 24 inches of teak coated with 5 inches of wrought iron to every shot. But both stem and stern are built inside of such immense strength that coating with armour-plates would be almost superfluous. The bows, as the spot where the whole shock must be received in running down ships, are inside a perfect web of ironwork, strengthened back to the armour-plates with no less than eight wrought-iron decks an inch thick, and crossed and re-crossed in all ways and methods with diagonal bracings and supports.

In the design sent into the Admiralty by the Thames Shipbuilding Company, the shape of the bows was made exactly after the outline of the neck and breast of a swan when swimming. Thus the point which would strike an enemy's vessel was the "breast," which was placed under the water-line. In the Admiralty model, according to which the "ram" is to be built, the bows form an obtuse angle, the point of which is just level with the water, receding back at a rather sharp slope both above and below it. This peculiar shape, however, will be concealed under the usual figurehead and forward gear with a light artificial cutwater of wood, so that apparently the vessel will be an ordinary frigate of the largest size. The Admiralty, no doubt, intend by these devices to disguise her real character, but we need hardly point out how utterly futile such an attempt would be. Once a general engagement was commenced, the "ram" would be able to pursue her mission of destruction by running into the sterns of the enemy's vessels almost without hindrance. The mode in which she attacks will be to run straight at the enemy, taking him if possible in the stern or quarter, all the men on deck retiring to the stern to avoid injury from falling spars. When about half the vessel's length from the enemy, the engines are to be stopped and the engineers stand by to reverse the engines in order to clear her from the wreck of her antagonist before the latter goes down. It is calculated that striking a line-of-battle ship in the stern, the ram would sink her within three minutes. The bowsprit will, we believe, be telescopic, in order to be housed on board with the anchors before striking the enemy, that there may be no chance of becoming entangled with the wreck of the sinking vessel. It has however, yet to be explained how she is to get rid of her own wreck of masts and spars, and above all what precautions will be adopted to prevent any chance of the rigging fouling her screw. The cost of the hull will be about 200,000*l.*, the engines about 75,000*l.*, and her fitting for sea about 45,000*l.* more—or 320,000*l.* in all. If she only does one-half of what may fairly be anticipated from her, she will be cheaper to the nation than a dozen sail-of-the-line. We abridge these interesting details from the *Times* journal.

SIR HOWARD DOUGLAS'S IMPROVED SCREW PROPELLER.

SIR HOWARD DOUGLAS has long devoted his attention to the improvement of the Admiralty Screw, and his exertions have been successful. The main object was, of course, to ascertain the shape of a propeller which would diminish vibration while exerting increased power, and therefore obtaining increased speed, so as to prevent the unpleasant effect produced by the constant tremulous vibration in the stern of a ship while the screw is in motion, which is dangerous; and the injury done to the stern by the constant shake of the screw may produce results to be dreaded. Of course, whenever there is great vibration there is loss of power somewhere, and the force that should here be exerted to propel the ship is lost in shaking her frame to the very centre. This most unprofitable result Sir Howard Douglas's experiments showed conclusively was due to the angular fan-shaped form of the Admiralty screw, and caused by the sudden and violent reaction of the disturbed water in the screw frame as the propeller entered and emerged from it. The rectilinear edges are in this respect highly disadvantageous, since the whole of an edge enters and leaves the water at once on each side of the aperture of the screw-frame, within which aperture the water is comparatively in a quiescent state as regards propulsion. This led Sir Howard to see that if the leading corners of a screw blade were curved, "they would slide obliquely and continuously through the water like a screw formed with an entire feather, so that at no moment would there be any shock or discontinuity of action." The result of this important discovery Sir Howard communicated to the Admiralty, but three engineers were against the proposed improvement, and considered that, to cut off the "leading corners" of the Admiralty screw would be to deprive it of half its propelling force. Sir Howard, however, took out a protective patent for his improvement, which is registered as consisting, first, in a modification of the form of the blades, so that the advance or leading edges of the propeller blades shall receive less shock in cutting through the water, and therefore produce a more equable action of the propeller, resulting in less tremulous motion in the stern of the ship when under way, and also steadying and equalizing the propelling force. For this purpose the advance edge of the screw blade is of a convex curved form, so that the curve of this edge of the blade at the extreme end is in rear, as regards its position in the screw, of the inner termination of the curve, or that next the centre. The leading edges of the screw, in fact, when looked at in profile, resemble a wave-line similar to Hogarth's line of grace and beauty, the two curves meeting in the centre at the boss or axis of the screw. By this form of the advanced edges the transition in entering and leaving the opening in the deadwood or screw-frame of the ship is easy and gradual; vibration in the stern-frame is reduced to its lowest point, and the whole force of the screw employed to propel the vessel.

A full detail of this improvement and its value to the service has been published by Sir Howard Douglas in his work on *Naval Warfare with Steam.* Nothing, however, was done towards cutting off "the leading corners" of the screws, as Sir Howard had recommended; but in June last, Her Majesty's frigate *Doris* was ordered to Spithead to make certain trials with various kinds of screws, but more especially of the comparative merits of Griffiths's screw and the common Admiralty screw, with its leading corners cut off. The result of these trials (detailed in the next page) showed that when competing with three of Griffiths's best screws (which were the best of all sets of improvements tried), the Admiralty screw, with its leading corners cut off as Sir Howard had recommended, was far better than two of the three, and very little inferior to the best of all. The value of the improvement was therefore put beyond a doubt, for the trial naturally created the impression that had a screw been specially made on Sir Howard's plan, instead of having its leading corners roughly cut off for the occasion, it would have distanced all competitors, both as regards increased speed of the vessel and diminished vibration at the stern. This was a great victory for Sir Howard's principles, and accordingly he received congratulations from all but the Admiralty, which alone made no sign. Sir Howard then wrote to the Admiralty, who replied that his improvements of 1858 had been tried previously by the Admiralty on board Her Majesty's yacht *Fairy* in 1853. Now, this latter assertion is very far from being correct. The trials made on board the *Fairy* six years ago were with screws of a peculiar form, cut down into any or almost no form whatever. The screws, too, were utterly different in principle and pitch from the Admiralty screw which Sir Howard proposed to improve, while the trials themselves may be regarded as conspicuous failures, inasmuch as they resulted in nothing, and left the old fan-shaped Admiralty screw precisely as it was, and as it has remained till the present improvement of Sir Howard. The gallant veteran has replied to the Admiralty, calmly persisting in his claim to the merit of having originated the improvement, and hinting strongly that the attempt of the authorities to refer back the improvement to the meaningless trials of 1853 with totally different screws looks very like trying to rob him of the honour due to his skill and perseverance in having been the first to see and the first to work out this important modification of the screw-propeller principle. So the matter remains at present. We abridge the above from the *Times* of August 27th,

The writer next refers to another important improvement of the screw, to prevent its being fouled by rigging or hawsers. In the whole of Her Majesty's navy not a single vessel is provided with any appliance to ward off this most obvious and most serious disaster. In Sir Howard Douglas's improved form of screw, the curved edges have, besides the advantage of readily throwing off any floating materials that may come in contact with them, that of not being so liable to be broken by their oblique collision with large spars. The angular parts of the common screw are far more likely to be hitched by ropes than the rounded extremities of the form which Sir Howard has now, we hope, introduced to the navy. These curved edges, he also suggests, should be fitted with sharp gun or other hard metal edges, so that as the screw revolved in the water its power would divide any rope or spar like a powerful circular saw. But his main recommendation as a remedy for this great evil is a contrivance that will enable the propeller to clear itself of any floating wreck of rigging which may hitch upon the screw in its rotation ; and which, being drawn down to the root of the blade, would be wound up on the boss so tightly as to disable the propeller or break the screw-shaft, if the engines were not instantly stopped. For this manner of clearing the screw Sir Howard proposes to employ powerful and sharp knife-edges, firmly fixed to the metal trunk in which the screw works, and close to both edges of the blade, in such a manner that any rope that may have hitched on the boss would be acted upon during the revolution of the screw as a body revolving in a turning lathe is acted upon by a chisel. Thus, revolving with a force derived from the power of the engines, the rope must be drawn into and along the knife-edges, causing them to exert a drawing cut sufficient to sever any rope, whatever its strength or thickness, and so clear the screw at once of what would otherwise be the most dangerous and perhaps fatal entanglements. This simple but most efficacious plan we trust soon to see generally introduced into both the Royal and merchant navies.

EXPERIMENTS WITH SCREW PROPELLERS.

THE series of screw trials concluded by the *Doris* are the most important that have yet taken place since the introduction of the screw for the propulsion of our steam-ships of war. These trials were designed to test the relative qualities of the Admiralty or Common Screw and Griffiths's Patent Propeller. Similar trials were carried out in 1853, on board the *Conflict* and *Fairy*, resulting in favour of the Griffiths's patent propeller, since which time the Griffiths has been constantly used by the *Fairy* when under way. The immense power of the engines now in use by our steam-ships of war has given an opportunity of testing the merits of the two screws with the certainty of obtaining more practical results, more especially as affecting the vibration and steering of the ship than could be arrived at with vessels of the *Conflict* and *Fairy's* class; hence the present trials. The forms of the screws may be thus described:—The blades of the Admiralty screw consist of a sixth part of the whole screw or helix; the centre of the Griffiths propeller is a sphere of one-third the diameter of the screw, with the blades made tapering. The driving surface of the Admiralty lies at the extreme end of the blades; in the Griffiths it lies at the centre nearest the sphere. The first trial with the Admiralty screw was with a diameter of 18 feet, her speed being 11·823 knots. On the second trial, with the diameter increased to 20 feet, the speed realized was 11·826 knots, with a great increase of vibration. On the third trial the "leading" corner of each blade was cut off, and in this form the common screw attained its greatest speed, giving a result of 12·032 knots. On the fourth trial, both the corners of each blade were cut off, when, with a greater number of revolutions, less speed was made, being 12·012 knots. Its last trial, with the "following" corner of each blade cut off, but the screw restored to its perfect form in every other respect, gave a result of 11·815 knots. The first trial with the Griffiths propeller—20 feet diameter and 32 feet pitch—gave 11·981 knots. The second trial, with a 26 feet 5 inch pitch, gave 12·269 knots; and the third trial, with a medium pitch, which concluded the series, gave 12·158 knots, with 53¾ revolutions of the engines, and less vibration than on any former trials. Several important features connected with the screw propeller have been proved by these trials. First, that the leading edge of the screw is the part that mostly affects the steerage of the ship, and also causes the greater part of the vibration. Secondly, that increased diameter of the screw is better than increased pitch to reduce the speed of the engines, but it considerably increases the vibration with the common screw; whereas with the Griffiths it did not produce that effect, in consequence of its chief propelling surface being towards the centre. The common screw, when its blades are cut to the form of Griffiths's, is not so effective as when the centre sphere is applied to them; the power required to obtain the same speed is considerably reduced by its application. The power required to obtain 12 knots without the sphere was 2,920·32 indicated horse-power, while the same form of blade and pitch with the sphere took only 2,825·6 indicated horse-power.—*Times.*

IRON STEAM-SHIPS.

MR. W. LITCHFIELD, in a letter to the *Times*, writes:—"The awful catastrophe of the loss of the *Royal Charter* (October, 1859), and her speedy breaking up on the rocks in Molfre Bay, has recalled to my mind certain discoveries which have of late been made by the officials of Her Majesty's Dockyard at Portsmouth in relation to Iron Vessels, which I think cannot be too widely known, and may possibly have some connexion with the aforesaid breaking up of the *Royal Charter*. Iron steam-vessels have arrived home from foreign stations to a certain extent leaky, and after being paid off and cleared out have been taken in hand for the necessary repairs. On the insides of the vessel's plates being examined, it has invariably been found that the whole of the rivet heads, wherever the wash of the bilge-water reached, had been worn off as cleanly as if cut by a hammer and chisel. This has led to a composition or cement being used over the surface of the plates of sufficient thickness to raise the surface of the plate to an equality with the head of the rivet; and in some cases bricks have been laid on the top of this cement, thus presenting a smooth surface to the wash of the bilge-water, and preventing its action on the head of the rivets. In every case where this has been tried, the results have been perfectly successful, the heads of the rivets after considerable service being as sound as the first day they were made. On the contrary, where the rivets have not been protected, but left to the action of the water and grit, in every case have the heads of the rivets been destroyed, and with nothing to prevent their falling out the first severe strain the vessel should meet with at sea.

"Her Majesty's troop ship *Megæra*, now in the steam-basin at Portsmouth, and lately returned home from foreign service, is an illustration of what I have stated, and thousands of rivets are now in her bottom which can be knocked out by a common punch from the inside. The plates of the *Royal Charter* may have been protected in a manner that would preserve their fastenings, or they may not have been."

STEAM FIRE-ENGINE.

EXPERIMENTS have been made with a view of testing the efficiency of a new Steam Fire-engine which has been completed by Messrs. Shand and Mason. The whole machine is mounted on high wheels, with a fore-locking carriage, and is, of course, intended for rapid transit by means of horses. The box contains the hose and implements, with a driving seat and space for firemen. Its extreme dimensions are 12½ feet long by 6 feet 5 inches wide, and 8 feet high without chimney. The total weight, including firemen and all implements, is nearly 3 tons, or almost double the weight of the ordinary Brigade engine. This increase of weight is apparently the only disadvantage which it possesses when compared with the common Brigade engine. Like the common fire-engine, this one by steam can be worked either with a suction-pipe, or water may be drawn from the cistern, which forms part of the engine itself. The steam cylinder and pumps are made entirely of gun-metal; the valves of india-rubber, as in the floating steam fire-engine; and the whole machinery is of the simplest and strongest construction, and not liable to be damaged by any amount of jolting over rough roads. The boiler is of the upright tubular construction, affording ample means for super-heating the steam; there are 199 brass tubes, 1¼ inch outside diameter, and 15 inches long. The firebox is of copper, 3 feet 4 inches diameter; the cylinder is 8½ inches diameter, with 6-inch stroke; one water cylinder is 6 inches diameter, with 6-inch stroke, the other 7⅜ inches diameter, with a 4-inch stroke, the two being equal in cubic contents.

In designing this engine other important circumstances besides obtaining the best theoretical steam pump have had to be taken into consideration, such as weight, bulk, means of transit, and accommodation for hose, implements, &c. The London Brigade engines have pumps consisting of two single-acting cylinders, 7 inches diameter and 8-inch stroke. The average rate of working at fires is not more than 40 strokes per minute; and as the cylinders contain 616 cubic inches, it follows that a London Brigade engine delivers at its average rate of working 88 gallons per minute. The water cylinders of the steam fire-engine contain 340 cubic inches, and as it can be readily worked at no less than 218 strokes per minute, it will thus be equal to three Brigade engines at their ordinary rate of working. The rapidity with which steam can be generated is, of course, an important point in the construction of a machine required for duty on the most sudden emergencies, and this point had been well and satisfactorily ascertained before the preceding trials. Nevertheless, in the course of the experiments it was demonstrated that a pressure of 10 lb. steam could be generated in six minutes from the moment of lighting the fires; a high pressure was obtained in 10¼ minutes, and the engine was immediately in full work. Of course, in the case of an engine of such description being generally adopted, as there is no doubt that eventually it will be, the fires would always be kept laid, and lighted while the horses were being harnessed; so that the whole machine would be in full motion on its way to a fire. In the above experiments, while working easily, the engine threw a ⅞-inch jet of water in a perpendicular column 130 feet into the air, while a column of 1-inch diameter was thrown in the same manner upwards of 90 feet; whereas, a Fire Brigade engine cannot throw a ¾-inch column more than 40 feet high. The most striking evidence of its superiority was, however, shown when it supplied two hose and threw two ¾-inch columns 60 feet high, and three columns of the same dimension more than 40 feet. This was not only throwing more water than three of the common Brigade engines, but throwing it to a height which the whole of them united could never maintain. When tried horizontally, the immense superiority of the steam-engine was equally apparent: the 1-inch column of water was thrown over the ground to nearly 140 feet, and the ¾-inch jets went to a greater distance, and more steadily. The whole experiments were in the highest degree successful, and we trust ere long to see this important invention entirely supersede the "established" engine, which in point of efficiency is about fifty years behind the age.—*Times*.

AMERICAN STEAM FIRE-ENGINE.

The *Scientific American* states that one of the newly-constructed locomotive steam fire-engines lately ran twenty miles on a common road. The whole weight of the engine, water, and nine passengers is 12,000 lbs., 9000 lbs. being the weight of the engine alone. The first three miles were made in sixteen minutes running time; it went over a bridge 350 feet long, with a draw of 40 feet in the centre, and up a very heavy grade, making 1000 feet in exactly one minute. The time occupied in travelling the twenty miles was two hours, grades and all included.

CHANDLER AND OLIVER'S STEAM PLOUGH.

Among the persons who have now for some years been working and expending money in furtherance of steam ploughing, is Mr. Chandler, but lately a working engineer at Bow, and associated with him, Mr. Oliver, of Hatfield, in the neighbourhood of the Marquis of Salisbury's estates. These two inventors have from time to time patented several valuable improvements in agricultural apparatus, and have recently added to their inventions an improved form of Plough, to be hauled by steam power, which many very experienced agriculturists have extolled, which several implement-makers have coveted, in so far as its manufacture is concerned; and which Messrs. Howard and Co., of the Britannia Iron Works, Bedford, are now engaged in producing to order. This improved plough has, undoubtedly, many advantages nowhere else to be met with. It is a balanced apparatus, like Fowler's; but the ploughs are carried by two independent frames, one on each side of the middle of its length. The balancing is effected by rods or chains extending from the extremities of these frames to arms on a rocking shaft at the middle of the plough, or in any equivalent manner; and the inner ends of the plough frames are connected with racks and pinions, or other appliances, whereby they may be raised and lowered—the one rising as the other descends. Thus the inner ploughs, which in Mr. Fowler's arrangement must be situated at some distance from the centre of the machine, in order that they may rise and fall sufficiently to clear the ground, and to enter it as desired, may here be brought close up to the centre. Consequently, Messrs. Chandler and Oliver's machine may be made much shorter, and, therefore, much lighter and cheaper than Mr. Fowler's; and the ploughs may be raised when out of action, and lowered into action with great facility. They also plough up closer to the headlands than the Fowler plough, and besides this afford facilities for reducing or increasing the breadth of the furrow, according to the nature of the land under operation.

This new implement is engraved in No. 1 of the New Series of the *Mechanics' Magazine;* and we take this opportunity of congratulating our old and able contemporary upon the manifold improvements in his valuable Journal.

TIMBER FOR SHIP-BUILDING.

Mr. Leonard Wray has read to the Society of Arts a paper on "Timber for Ship-building." After pointing out the magnitude of the interests involved in the question, the author drew attention to the small number of timbers which were considered as first-class by the authorities of Lloyd's; and, although he approved generally of the rules adopted by that body, he thought that future experience would enable them largely to extend that list. He pointed out the important influence that locality and climate had upon the quality of any particular class of timber; instancing particularly the teak, which was so highly esteemed, but the durability of which was found to vary considerably, according to whether it was grown in high and open land, or in a close, low-lying forest. The finest kinds of mahogany were, perhaps, the best timber for ship-building, though too costly to be generally employed; but good mahogany of a more moderate price might advantageously enter more largely than it now did into the construction of ships, though its more extended employment must be regulated with judgment and discretion. Mr. Wray next pointed out how much we were indebted to Mr. Temple, the present Chief Justice of Honduras, for directing special attention to the capabilities and resources of that fine colony. The forests of Honduras contained many kinds of wood which were adapted for ship-building, and the author was of opinion that they would well repay the expense of bringing to the English market. After alluding to our three settlements in the Straits of Malacca, to the Tenasserim provinces, and to the forests of the southern parts of Western Australia, all of which contained valuable woods,—the author concluded by urging the importance of adopting means of preventing ships' timbers from rotting, by impregnating them with some preservative fluid.

EXTRAORDINARY TIMBER.

SOME specimens of Timber recently imported from the North-West Coast of America, have been exhibited at the Institution of Civil Engineers, by Mr. G. R. Burnell. It was observed that the quality and dimensions of this timber, which came from near Vancouver's Island and the district bordering upon British Columbia and California, appeared to be such as to justify rather more than the passing notices hitherto given in the technical journals of the metropolis. There were now lying in the Commercial Docks between fifty and sixty logs of this timber, upwards of 100 feet in length, and measuring at least 22 inches on a side. There was one log in particular, which was 129 feet long, die square, perfectly straight and sound, apparently free from dead knots or shakes, and measuring 39½ inches on the side at the middle of its length. At the butt end it was nearly 4 feet square; and at the taper end it was about 2 feet 4 inches square; and it contained 1302 cubic feet, or upwards of twenty-six loads. No experiments had been made on the specific gravity, or on the strength of this timber; but from the manner in which it floated, it would appear that its specific gravity was about the same as that of yellow pine. The strength would appear to be equal to that of the best crown Memel, if an opinion might be formed from the way in which some planks had been bent, and the conditions of elasticity indicated under such circumstances. For bridge-building, roofing, and scaffolding purposes, it was suggested that this North-Western American fir would be of great value, on account of its length, and its remarkably uniform character. Some light spars of the same kind of wood, about 119 feet long and 15 inches diameter at the butt end, had also been imported from the same coast. The price of the very long spars was, at present, about six shillings per foot cubic; this was high, but no doubt it would hereafter be diminished. The price of ordinary lengths was nearly the same per foot cube as that of the best crown Memel deals. Attention was directed to the number and closeness of the annular rings, which indicated that the trees were of slow growth; and it was thence inferred that the wood would probably be durable. It was suggested that it would be desirable to make some experiments of an authentic character on the properties of this timber.

The following particulars of gigantic timber in the above Docks, have been communicated to the *Builder* journal by Mr. Nathaniel Gould, F.S.A.:—

"Our attention has been called to an importation of three cargoes of mast-pieces of timber, discharged in the Commercial Docks, Rotherhithe. The sizes, both in length and square, are so unexampled as to be worthy of record. One vessel, indeed, the *Bostonian*, of 1000 tons, has spars of a magnitude that we believe were never before made timber of commerce; they run from 90 to 140 feet in length, and from 26 to 40 inches square. One mast contains twenty-eight loads, weighing about thirty-three tons, and is (as are most of them) nearly as straight as a ruler, and without a knot; being 139½ feet long, and 39½ inches square. When felled, it measured 316 feet to the branching top, and for 150 feet was without any branch at all. It was squared to 41 inches; but was of necessity reduced to 39½ inches to admit of its entering the ship's bowport.

"The quantity of timber in this enormous tree is worthy of notice: call it 300 feet by 41 inches square, it would contain 3502 cubic feet, or 70 loads 2 feet as squared, or 116 loads as round timber. It would saw into 2050 boards 41 inches wide, ½ inch thick, and 12 feet long; or, allowing about twelve per cent. for waste in sawing, 1800 boards 36 inches wide by ½ inch thick, and 12 feet long.

"If laid out quite close it would cover 72,000 square yards, or 1 acre, 1 rood, 2 chains, 6 poles, 10 yards; or, allowing for unavoidable interstices, about two acres and a quarter.

"It is difficult to imagine a tree half as high again as the Monument before it branches out.

"These masts are considered worth from 12*l.* to 14*l.* per load, and we understand are secured for the British navy; and it is said that the longest may perhaps be raised as a flag-staff at Windsor.

"The quality of the timber is not precisely white pine, red pine, pitch pine, hackmatac, or cedar, having, in some respects, the qualities of each; and inclining perhaps to red pine. It swims lighter than pitch pine, has beautiful figure, and in taste has a small degree of acidity. It however appears not to have the peculiar character of the 'Wellingtonia Gigantea' as the specimen of the wood is exhibited at the Crystal Palace. The discharging of these enormous sticks from the vessel has been attended with great difficulty and expense, and was not altogether without danger."

In the *Times* of January 21st is the description of "a wonderful valley" in California, by C. D. F., called the "Yosemite," or Bear Valley. The writer says: "I wish to mention that near the road to this valley I visited a grove of the far-famed Wellingtonias, or mammoth cypresses, of which there are about 500 interspersed among numerous others less remarkable, though still very large. The largest I measured was 39 feet in diameter 6 feet from the ground, and was at the least more than 400 feet high. Another, which had fallen, and of which the bark alone remained, formed a tunnel through which three horsemen could ride abreast."

PRESERVING TIMBER FROM DECAY.

THE following plan is said to be common in Burgundy, for Preserving Timber from Decay and from Insects :—The wood having been steeped for forty-eight hours in a solution of copper—in the proportion of one kilogramme (about 2 lb. 3 oz. and 4 drachms) of sulphate of copper to 20 litres (about one quart) of water—must be allowed to dry in the shade, after which wash lightly with lime. If it does not acquire a bluish green colour, the operation must be repeated. This plan, it is said, is economical, and has been tried with success on fifteen different kinds of wood.—*Builder*, No. 835.

IMPROVEMENTS IN SHIP-BUILDING.

MR. CRISPIN, of Stratford, has patented "Improvements in the Construction of Ships and other Sailing and Steam Vessels." The hull of the ship or other vessel, is constructed of iron, which may be considerably thinner than that usually employed in iron ships; the same being covered externally and internally with wooden planking, bolted completely through the iron and wood, and so arranged as to break joint, and thus add to the strength of the vessel. The external and internal woodwork should be caulked, in order effectually to prevent leakage. In some cases, it may be desirable to place the external planking in the ordinary horizontal manner, and to arrange the internal planking diagonally; and where great strength is required (as in ships of war) the series of wood, iron and wood, may be duplicated or tripled. The hull thus constructed admits of being sheathed with copper or other sheathing metal, and thus obviating one of the great objections to iron ships; while in the case of ships of war, the arrangement of wood and iron, in accordance with this invention, will prevent the disastrous consequences occasioned by the fragments of iron, when ships, built entirely of that material, are struck by shot, at the same time much greater facility being afforded for repairing the shot-holes. The deck of the ship or vessel may be constructed upon the same principles as the hull, in which case it may be desirable to place the lower or under planking transversely or across the ship. — *Mechanics' Magazine.*

NEW SHIP'S WINDLASS.

THIS new Windlass was originally an American invention; it is stated to have been applied very successfully to a number of vessels on the other side of the Atlantic; and, considerable alterations having been made in this country to improve and strengthen it, Messrs. Emmerson and Walker, the patentees of the invention in its new form, now submit it to the judgment of experience. The peculiarity of this invention consists in its being a combination of the capstan and windlass, and in an ingenious arrangement of the parts, by which either a very heavy purchase or a quick motion may be had at will, simply by turning the capstan round, with the sun in the one case, and in the other against it. The two ends of the windlass which take the chain can either or both be placed in connexion with the capstan, and the result is that one chain only, or two at one time, can be worked with equal facility. The chains, it is stated, require no fleeting, but are drawn directly from the lockers, are not liable to surge, and can be paid out, checked, or stopped, at any moment, by one man at the break. The windlass is simple in its construction, and so compact that it occupies only a space of 7 feet 6 inches by 4 feet 6 inches.

MODIFICATIONS OF SHIPS OF THE ROYAL NAVY.

A PAPER of immediate interest and value in connexion with the subject of our National Defences, has been read to the Society of Arts, by Mr. E. J. Reed, "On the Modifications which the Ships of the Royal Navy have undergone during the present century, in respect of Dimensions, Form, Means of Propulsion, and Powers of Attack and Defence." Mr. Reed began by observing that the science of naval architecture was so greatly advanced on the Continent, and so much neglected in England, during the last century, that the forms, dimensions, and speed of the ships of the British navy were, for the most part, inferior to those of every other nation with which they had to cope, the tendency then being greatly to overburden vessels. The author touched upon the source of some of our naval disasters during the American War, and then passed to the improvement in construction introduced by Sir Robert Seppings, whom he thought deserving of much credit. The unfavourable influence exercised, in Mr. Reed's opinion, by Sir William Symonds, while Surveyor of the Navy, was then pointed out, his opposition to the use of the screw-propeller, now so universally adopted, having considerably retarded our naval progress. The author passed on to describe the state of the navy during the late Russian war, and maintained that the spectacle of one Russian fleet sunk by Russian hands at Sebastopol, and of another trembling behind stone fortresses in the shallow waters of Cronstadt, was one the record of which we certainly might read without shame. He then gave a rapid review of the present state of the navy, and expressed his opinion that floating batteries had met with undeserved condemnation. The subject of the steam-ram, which had attracted considerable attention, was then discussed, the author's opinion being that it would be found to be so unwieldy in its character, that ships would have no difficulty in avoiding collision with it. In conclusion, Mr. Reed maintained that while it must be allowed that considerable improvements might be made in the construction of our ships, yet that such alterations would prove enormously expensive, besides being of very questionable policy; for by eagerly arming ourselves with all the warlike agencies which science could suggest, we might make our navy most terrible, but we should at the same time, by the very preponderance of our might, compel all other powers, secretly at least, to make common cause against

SUBMARINE WARFARE.

In the *Mechanics' Magazine* for Jan. 14, we find described an American Submarine Boat, resembling a porpoise, capable of containing fifteen men, if necessary. The inventor has, with others, sunk in Lake Michigan, and remained under water for four hours without any communication from the surface, and has propelled the boat in and near the bottom of the lake for several miles, at three miles an hour. He has, while under water, by machinery working through the boat's side, sawed off timber 14 inches square. He can sink his boat from the surface almost instantly, either to a few inches, or to 100 or more feet, and again rise quickly or slowly to the surface; go forward, back, or sideways, or come up bows first or otherwise, as may be required. He can carry powder torpedoes under water out to sea, in any weather, to an enemy's ship, fix or anchor the torpedoes under her bottom, set in motion clockwork to fire the torpedoes, and retire out of danger. He can enter an enemy's harbour under water and make surveys, only showing above the surface a sight-tube half an inch in diameter, retire, and make his report. He can go out to sea, meet a hostile fleet, go under their bottoms, fix torpedoes, or bore holes, and come away unseen. He can carry a gun so rigged that he can load in 100 feet of water, rise near to the surface, sight the horizon for an enemy's ship, proceed within a stone's throw of her, rise quickly, so as only to show the muzzle of the gun through the outside port-hole valve, aim at the ship, fire, then instantly sink to reload, and rise at another point to fire again. If required, he can remain under water with several men for several days, without landing, or showing his boat above water. For pearl fishing, he can work all day on a pearl bed, raking up and taking in pearls, and moving about and finding them where a diver would not. If required, on visiting wrecks, he can saw, bore, or make fast chains or ropes to any point of the wreck, go out of the boat through the side-hatches, enter the vessel, and return inside again without inconvenience. In our judgment, the submarine dress or case which the inventor has devised for these latter purposes, is a most complete and useful contrivance. The secret of this wondrous invention has been offered for sale to the American, French, and British Governments, successively; but we have not heard of its being entertained by either.

AN AMERICAN GUNBOAT.

ONE of the seven vessels last ordered by Congress—the steam gunboat *Seminole*, has been launched at the Pensacola navy-yard, and is thus described in the *New York Times*. Her model was drawn by Naval Constructor Porter. She is a bark-rigged steamer of 800 tons burden, and built on the genuine gunboat principle, which means that she can carry a very heavy armament into shallow water, and that she combines strength and roominess with swiftness and comparatively small proportions. One of her guns will weigh no less than 25,000 lbs., and is a most destructive weapon. Besides this, two 32-pounders of 42 cwt. each will be on board, making the *Seminole*, when well manned by expert sailors and marines, a powerful (although somewhat diminutive) antagonist to ship or fort. The machinery of the vessel is of the first class. It consists of two splendid engines of the "horizontal back-acting steeple" description, 750 horse-power, with cylinders 50 inches in diameter and 30 inches stroke. The pistons are connected with cross-heads by two rods. There are a Purson's patent steam condenser nearly finished, and two pumps, one for air and the other for water, worked by projecting arms forged on the lower piston rods, attached to the machinery. The boilers, of which there are two and an auxiliary one, are Martin's patent, measuring, respectively, 21 feet 6 inches long (six furnaces) and 18 feet 1 inch long (five furnaces). The "auxiliary" is smaller than these. Both boilers are of the same height—viz., 9 feet 8 inches, and the same depth, 9 feet 3 inches. The propeller is of brass, a two-bladed true screw, 9 feet 6 inches in diameter and 17 feet pitch. The total weight of the machinery is 301 tons, and the consumption of coal about 22 tons per day. She is expected to make 10 or 11 knots the hour under steam alone, and from 11 to 18 under steam and canvas. The great perfection of gunboats may be briefly classed under three distinct heads:—1. They are small, can carry heavy metal into shallow water, and can move quickly, being steamers. 2. They are easily manned and easily equipped for sea at very short notice, besides being "handy" to execute with alacrity Governmental business and squadron duty requiring a national vessel, but no display. 3. In line of battle they are considered on a par with sailing frigates,—first, because they can effectively use at least three heavy guns at all points of the compass, while presenting an exceedingly small mark for the enemy's ordnance; second, they can "choose the time and tide" for fighting, as circumstances may dictate; thirdly, anticipating defeat, they can make discretion the better part of valour by an expeditious retreat. But here end their commendable attributes. They cannot properly accommodate a crew and carry provisions to support it, or coal to fire up with for any considerable length of time. In time of war, as a modern naval battle would be conducted principally by steam-vessels of large dimensions, the only use a gunboat could be put to would be either to act as a tender to larger craft or to capture merchantmen.

DESTRUCTIVE ENGINES OF WAR.

IN the *Times* of March 31, 1859, appeared a communication from Dr. Lardner, calling attention to many chemical agents which might be employed with advantage in warfare.

"If an objection (says Dr. Lardner) to what I suggest be raised on the score of humanity, it may be answered by the fact, that in proportion as the destructive power of warlike agents has been augmented, the proportion of life lost in war has decreased. The invention of gunpowder has been the means of saving thousands, even millions of lives.

"Compounds are known in chemistry which, when exposed to the air, spontaneously ignite, diffusing through the surrounding atmosphere gases, or vapours, of odours so insufferable, that men forced to respire them would be rendered utterly incapable of all effectual action. Shells charged with such compounds, exploding in the gun-room of a vessel, or anywhere between decks, would, without destroying life or limb, disable the enemy. Compounds having such properties are very numerous.

"But there are others of a much more formidable character which chemistry can readily supply.

"There are certain compounds called in chemistry by the not very euphonious name, 'kakodyles,' of which arsenic is one of the constituents, which, on exploding, not only diffuse exhalations which render the surrounding atmosphere so fetid as to be absolutely insufferable in respiration, but impart to it also qualities which are poisonous in the most deadly degree. These compounds being eminently volatile explode spontaneously when exposed to the air. In burning the metallic arsenic, one of their constituents, combining with the oxygen of the air, forms fumes of white arsenic, which, being diffused through the surrounding air, kills all who breathe it. What the effect of shells charged with such compounds would be, bursting in a ship, or within a besieged fort, or in the midst of closely-packed ranks, need not be described.

"The chemist can supply many compounds, having these properties in different degrees.

"But the laboratory can furnish agents still more destructive. There are compounds into which the gas called cyanogen enters in combination with arsenic. A shell charged with such a compound upon exploding would produce terrific effects. The humidity with which the surrounding air is always more or less charged would be decomposed; its oxygen, combining with the arsenic, would form the vapour of arsenious acid, which is the substance commonly called arsenic, and known as a deadly poison, while the hydrogen, the other constituent of the decomposed moisture, combining with the cyanogen, would form the still more fearful poison called by chemists hydrocyanic acid, but more familiarly known to the public as prussic acid. Thus, by the explosion of such a shell the surrounding air would be instantly impregnated with the vapours of two of the most fearful poisons known in medicine.

"It is easy to perceive what formidable missiles might be produced by such shells thrown into towns or among crowded bodies of men from distances of six or eight miles by the artillery recently invented. Before such agents gunpowder would 'pale its ineffectual fires.'"

EXPERIMENTS WITH A BALL FILLED WITH MOLTEN IRON.

THE *Stork* screw gunboat tender has been fitted with a furnace for filling hollow shot with molten iron, and the *Undaunted*, 46, frigate, prepared with iron plates of such thickness as to render her proof against a 68-pound shot at 400 yards' range. In November last the *Stork* went up Portsmouth harbour and moored off from the starboard side of the *Undaunted* 400 yards. A little before noon she hoisted a red flag, another being also placed on board the frigate to warn all boats off. At 12.30 the first hollow shot, filled with molten iron, was discharged from the *Stork*, and went clean through both iron plates and wood into the body of the ship, about four feet above the water line. A second shot was fired at a short interval, when smoke was perceived to burst through the ports and hatchways, and in a few minutes more a body of flame. The ship was on fire. As soon as the fire was observed, the *Stork* slipped her moorings, and steaming up to the head of the *Undaunted*, set the fire-engine to work. Signal was also made to send a body of men from the *Excellent* to man the large floating fire-engine, and to the *Comet* Government tug to tow up with all haste to the rescue. Such, however, was the destructive nature of the molten iron, that the doomed vessel was soon one solid mass of flame, and it was considered by Captain Hewlett expedient to scuttle the ship, which was accordingly done. After firing six rounds into her between wind and water, down she went at her moorings, leaving only the toprail of her forecastle deck and poop visible. It is impossible to attach too much importance to this undoubted proof of what a gunboat fitted like the *Stork* can do against an enemy's line-of-battle ship. A ship as large as the *Duke of Wellington*, 131 guns and 1200 men, would have shared the fate of the *Undaunted*.

IRON AND STEEL PLATES AND HEAVY ORDNANCE.

A SERIES of experimental trials has been made at Portsmouth, with a view of ascertaining the amount of resistance offered by iron and steel plates of various manufactures when opposed to heavy ordnance at a short range. The trials are understood to have reference to the future coating of the steam-ram now in progress of construction. The practice has been carried on from the *Stork* gunboat, tender to Her Majesty's ship *Excellent*, gunnery ship in Portsmouth harbour, both from a 32-pounder and a 95 cwt. gun, the latter throwing a solid 68 lb. shot, with 16 lb. charge of powder; the distance of range 200 yards. At this distance the results of the experiments have demonstrated in the clearest possible manner that no iron or steel plate that has yet been manufactured can withstand the solid shot from the 95 cwt. gun at a short range. The first shot would not penetrate through the iron plate, but it would fracture it, and on three or four striking the plate in the same place, or in the immediate neighbourhood, it would be smashed to pieces. As the results of the trial affected the steel plates it proved that a steel-clothed ship could be far more easily destroyed than a wooden-sided one, and that on the smashing in of one of the steel plates the destruction of life on the armed ship's decks, supposing the broken plate to be driven through the ship's side, would be something dreadful to contemplate, from the spread of the splintered material. At from 600 to 800 yards iron-clothed ships would be in comparative safety from the effects of an enemy's broadside; but it must be borne in mind that the effects of concentrated firing have yet to be ascertained on the sides of an iron or steel-clothed ship, and account also must be taken of the damage the woodwork forming the inner sides of such a ship would receive from the driving in of the broken plates, and which, as far as the present experiments have illustrated, would appear to prove that an iron or steel-clad ship, on receiving a concentrated broadside from a frigate, armed in a similar manner to the *Mersey*, and struck near her water line, must sink then and there, with her armour on her back.—*Times*.

AMERICAN NEW RIFLE CANNON.

THE *New York Journal of Commerce* gives a synopsis of the official report on the New Rifle Cannon experimented with at Chicopee, Massachusetts. It stated :—

"The Board convened June 7, and continued their experiments for several days. The guns examined were a 6-pound bronze canon, with 3·80 inch calibre, and rifled 15 grooves; a 12-pounder, 4 inch calibre and same number of grooves. In both instances, the twist in rifling was equivalent to one turn in 60 feet at the beginning, and ending in one in 20.

"The projectile designed by General James for these guns is a cast-iron cylinder pointed by a solid conoid head, the diameter being only ·02 of an inch less than the bore of the gun, and the length twice the diameter of the calibre. The cylinder retains its full diameter for a quarter of an inch of its length at each end. For the intermediate length its diameter is reduced half an inch, forming a recess in its body, which is filled by a compound of canvas, sheet-tin, and lead. The base of the cylinder has a central cavity or opening of 1·95 inches in diameter, and 1·5 inches deep. When the charge is fired, the gas evolved by the burning of the powder, in its efforts to expel the projectile and to escape from the gun, is forced into the cavity against the compound filling, which is thereby pressed into the grooves of the bore, and by its firm hold in them the rotary motion is imparted to the projectile.

"The Board, having examined the guns and projectiles, proceeded to test their efficiency, the results of which were 'very satisfactory.' The report says, 'Respecting the guns, their merit is due to the rifling, which can be readily applied, at little cost, to all bronze cannon of the United States, and so render them as far superior to the present smooth bore guns as, in small arms, the most improved rifle surpasses the musket.'

"The depth of grooving is so shallow as in no wise materially to impair the strength of the gun, while it is sufficient to compel the projectile to take the rifle flight. The effect of these contrivances was exhibited in an extraordinary manner, by the increased range obtained while using the same charge of powder and elevation in projecting masses of double the weight of the usual spherical balls. The merits of the projectile are represented to consist in their 'answering fully the expectations desired of them; their ready fabrication and adaptation to guns; their ease in loading; the certainty of the expansion of the filling and its firm hold in the grooves of the guns. The greased canvas wipes the rifling clean, and leaves the bore in condition readily to receive the next charge, and which is also a sure protection to the bore from injury.' For these reasons the gun and projectiles are commended to the favourable consideration of the Government; and as the experimental firing was subject to several disadvantages which may hereafter be avoided, the Board recommend that guns of the service calibre be granted to General James, for rifling, according to his principle. We learn that another series of experiments is in contemplation, in which to compare, side by side, the performances of this new gun with those now in use. Of course the remarkable precision and power of the new rifled ordnance constitute its chief value, but the great saving of ammunition effected is a matter of no small importance. The results of the experiments above referred to are expressed in tabular form at much length. As an example, it is shown that in one instance 18 shots were fired a mean distance of 674 yards, at an elevation of one degree—the powder weighing 1¼ lb., the projectile 12¾ lb.—the deviation being only four inches to the right of centre, and half an inch above it. On reaching ground the missile was buried five feet in compact sand. In another instance a shot was fired 2050 yards, at an elevation of five degrees, and passed about 25 feet above the top of the hill toward which it was directed. The Board believe, from the testimony of several witnesses who were near the range, that the projectile 'continued its flight many hundred yards beyond the hill,' the summit of which was nearly on the same level as that upon which the gun was placed in battery. According to the statement of Mr. Ames, the manufacturer of the gun, who has carefully examined the ground, 'it is almost certain the ball went four miles.' After what is already known, it is safe to say that any object within the reach of an ordinary spy-glass is a fair mark for this terrible weapon. In one other respect the exploits of General James's gun demand attention. According to the laws of projectiles laid down in the *Ordnance Manual*, and which have long been established, as was supposed beyond power of refutation, the range of a 6 lb. shot at five degrees elevation and 1¼ lb. powder is 1523 yards; but, in the example now afforded, a ball 12¾ lb., with the specified quantity of powder, has gone between three and four miles. As compared with the celebrated Armstrong gun, the results are not less curious. Mr. A. claims to have thrown a ball 5¼ miles with six pounds of powder, employing an area or calibre of 3¼ inches,—which is a result of 55-100ths less favourable than that obtained by the experiments at Chicopee. According to the latter, any gun of calibre equal to Armstrong's will throw a ball, with less than half the powder, the full distance attained in his practice."

RIFLED GUNS.

Mr. Lynall Thomas's Heavy Rifled Cannon for Gunboats are thus described by the inventor in his paper, "On Experiments in Gunnery." He says our own heavy guns are constructed upon a principle so false that the only wonder is that so few accidents happen with them; those of the largest size are not only unsafe, but also very inferior in power to the American guns. If, however, it should be discovered that rifled guns of 6 or 8 tons weight—the weight of some of the guns employed in the American service—can be constructed of wrought iron, then, indeed, a powerful piece of ordnance will be obtained; a compound shell, of 2 cwt. and upwards, could be fired from it, and a greater range and accuracy combined would probably be attainable, than could be acquired with any other description of gun, such as could with convenience be used. A fortress or a floating battery, attacked with ordnance of this kind, could scarcely escape destruction. The length of the bore of Mr. Thomas's gun is 9 feet, and the calibre 8 inches; the metal which surrounds the charge is nearly 12 inches in thickness; this (if the guns were constructed of the new puddled steel) would probably be sufficient to give it ample strength, and weight enough to prevent great recoil. A shell of 2 cwt., and a charge of from 25 lbs. to 30 lbs. of powder, might be used with it. "A long, low, strongly-built vessel, possessing great steam power, armed with a gun of this kind, would prove," says Mr. Thomas, "infinitely more destructive than the steam battering-ram which has recently excited some attention. A vessel such as I have described would possess great advantage over a steam-ram, from the difficulty which would be experienced with the latter—first, in striking a vessel under sail or steaming; and secondly, in getting disengaged from it afterwards.

"Ten or twelve vessels of the above description—sea-going gunboats—each armed with a heavy rifled gun to throw shells of 2 cwt., and with steam power sufficient to give them a speed of at least fourteen knots, would, at a distance of three miles, lay any town on the coast in ashes, in a very short time, and with perfect impunity. This may be accomplished, and *will* be; if not by our own nation, by another. It is questionable, however, whether the 11 or 12-inch guns, such as form the armament of the American corvette *Niagara* would not prove more destructive in close action—from their large diameter and heavy bursting charges—than even the powerful rifled guns which I have described. Before adopting rifled guns into our naval service, to the entire exclusion of smooth-bored guns of large calibre, much consideration would be necessary, and many experiments required to be made. I see no reason, however, against the *acquisition* of such a gun as I have described. The only difficulties which lie in the way of it have already been once surmounted in the case of Mr. Horsfall's 13-inch gun, and will, no doubt, be still more completely overcome. The great tensile strength which is required for guns to throw compound shells arises from the absence of windage, and also from the friction on the whole surface of the bore, which impedes the progress of the shell along the bore, and allows the fluid produced by the fired charge to accumulate behind the shell, and thus to exert a great strain on the gun."

Mr. Haddan's Rifled Gun is thus described in the *Mechanics' Magazine*:—Mr. Haddan forms in the gun three shallow "curves," sinking only to about 5-16ths of an inch beyond the circular bore, and wearing off until they lose themselves in the circle of the bore. To these curves he gives a very slight twist—only about one turn in sixty feet, we believe, which is less than that given by any other of the competing gentlemen. His projectile has three swells or projections upon it to take into the grooves, and is formed with a conoidal head and a taper towards the rear end, on which end is placed a simple ring-formed wad. The projectile goes freely into the bore, and when the charge is exploded the centre line of the projectile is compelled by the conditions of the case to occupy the centre line of the gun, and pass out in that position. The projectile can be made as cheaply as any ordinary round shot or shell, being simply of cast-iron; and no great nicety is necessary in adjusting the size of the projectile to that of the gun. The wad is caused to clean out and lubricate the gun at each discharge, and both the gun and the projectiles may be used as roughly as ordinary guns, shot, and shell. An ordinary 68-pounder gun rifled on Mr. Haddan's plan has projected a 90 lb. elongated shell with considerable truth of aim over an average distance of nearly 3000 yards, with an elevation of ten degrees and a charge of powder of ten pounds, being, as will be seen, only 1-9th the weight of the shell. This was very good practice, and the method of rifling appears to us to be second to none, except perhaps the Lancaster system, for the present exceptional purpose of converting our old smooth bores into rifles, as it will in all probability weaken and distress the gun but slightly.

IMPROVED GUN AND PROJECTILES.

THIS Breech-loading Cannon, invented by Sergeant Warry, the armourer of the 3rd Battalion at Chatham garrison, has been so improved as to make the discharges even more rapid than before, the gun being now capable of discharging, with ease, 20 rounds per minute. This improvement is effected by a beautifully-contrived lever, placed on the side of the breech, which by one simple movement raises the cock of the gun, and opens the breech; the reverse movement entirely closing the breech, cutting the cartridge used, priming the nipple, and firing the gun all instantaneously—the effect of which is, that the cannon may now be discharged as rapidly as the charges can be inserted in the breech, as two simple movements are now all that is necessary to prepare the gun for being fired, and actually discharging it. The inventor has also effected an improvement in the balls used for breech-loading guns, for which he has applied for a patent. This improvement consists in the manner of coating the balls, the present lead and tin coating with which balls have hitherto been covered leaving a deposit in the gun which necessitates that the bore should be cleaned out after every few rounds have been fired, the Armstrong gun, for instance, requiring sponging after about every dozen rounds, and occasionally more frequently. To obviate this Mr. Warry has invented a chemical composition which he applies to the spherical balls used by him, and which answers its purpose so satisfactorily that after 50 rounds were fired the other day with these balls so coated, not the slightest fouling the gun could be detected, the breech, in consequence of the current of air admitted each time it was loaded, remaining as cool as at the commencement, while no expansion could be perceived. The inventor also states that by using his method a dozen balls can be coated for the expense now incurred in coating one on the old principle. It is a remarkable circumstance in connexion with this invention that shortly after the account of this new weapon first appeared in the *Times*, the inventor was waited on by the agent of a foreign Government, and offered the most handsome terms to transfer his invention to that Government, or part with the model of his gun, both of which offers Mr. Warry, for obvious reasons, declined, not even allowing an inspection of his model.—*Times*.

IMPROVED REVOLVERS.

THE utmost thought amongst military mechanicians is at present being exercised to improve upon the Revolver—a weapon of vital importance to the soldier. Such attempts, while they sometimes display considerable ingenuity, give us, for the most part, merely novelty as their result. Mr. Charles Reeves, the eminent contractor for arms, of the Toledo Works, Birmingham, has, however, patented a Revolver which may not be passed over without comment. It provides greater strength where the recoil of the chambers takes place, and thus fracture is prevented at that part. The action of the rod is likewise *direct*, but that which will ensure the greatest amount of interest is to be found in the arrangement which permits its owner getting immediately at the whole of the interior of the lock's machinery for examination, cleaning, and oiling. This is certainly a feature of improvement, as the user may be assured from time to time that all is right without waiting for the disturbing cause, which may alone present itself at the moment which may determine life or death. Reeves's pistol can likewise be half-cocked, for safety in loading, and secured in that position by an excellent bolt, thus preventing accidental explosion. It can be wholly cocked with the thumb in taking a deliberate aim, or the contents of all the chambers can be discharged instantaneously by the trigger; either of which operations can be performed without withdrawing the hand. The chamber revolves upon an axis which is removable at pleasure, but which cannot become displaced, as is too often the case in other arms of a like nature.—*Mechanics' Magazine.*

Messrs. Deane and Son have submitted for the approval of the military authorities a much Improved Revolver, the internal mechanism of which lessens the intricacy of the action, and by a very simple arrangement locks the hammer and cylinder in such a manner when not in use as to do away with the chance of accident. The improvement is termed the Deane and Harding patent, and among other valuable simplifications, has one by which almost instantly the cylinder and barrel can be separated from the stock for the purpose of cleaning. A powerful lever ramrod, acting vertically on the bullet, is also added.

NEW ARMY BLANK CARTRIDGE.

THE General Commanding-in-Chief has sanctioned the adoption of a new pattern Blank Cartridge, proposed by the Superintendent of the Royal Laboratories, for assimilating the method of loading with blank to that of loading with ball cartridge, and cartridges of this description are now ready for delivery. They are composed, like the service ball cartridge, of an inner bag, containing the powder; mock bullet, consisting of a paper bag, with a muslin bottom, filled with fine grain powder; and an outside bag to contain both. To ensure the flash of the discharge igniting the powder in the mock bullet, and to prevent its being projected from the musket entire, a portion of the bottom of the outside bag is cut away. No portion of the paper requires to be torn off.—*Mechanics' Magazine.*

THE ARMSTRONG GUN.

To the Derby administration is due the utmost credit for their immediate adoption of this unequalled invention in the science of war. Its origin was thus related by General Peel (the Secretary for the War Department), in moving the Army Estimates in Parliament, stating that—

> in the course of the summer of 1858, he appointed a committee to examine and report upon the different sorts of rifled ordnance which had been submitted to the Government. The report of that committee was entirely favourable to Sir William Armstrong's invention. The Gun submitted to the Government by that gentleman was a breech-loading, rifled, wrought-iron gun, of peculiar manufacture, throwing a projectile which answered as either solid or hollow shot, as shell, or as common case. This projectile could also be modified so as to be used by naval batteries and on board ships, and to have a very great explosive effect. The gun had great durability, he having himself seen one which had been fired 1300 times without the smallest injurious effect being produced upon it. The great advantages of this gun were its extreme lightness, the extent of its range, and its accuracy. An Armstrong gun throwing a projectile of 18 lb. weighed one-third as much as the guns now in use discharging shot of that weight. The range of a 32 lb. gun, fired with a charge of 5 lb. of powder, was a little more than five miles and a quarter, while the precision of the gun was still more extraordinary. The accuracy of the Armstrong gun at 3000 yards was as seven to one compared with that of the common gun at 1000 yards; while at 1000 yards it would hit an object every time which was struck by the common gun only once in 57 times; therefore at equal distances the Armstrong gun was 57 times as accurate as our common artillery. Its destructive effect, also, exceeded anything which had hitherto been witnessed. The carriages had been very much improved, and their introduction into the navy would greatly diminish the number of men required to work the guns. Having ascertained the superiority of the gun, the Government could have no hesitation in at once doing everything in their power to make themselves masters of it. Great as had been the ingenuity and talent displayed by Sir W. Armstrong in regard to this invention, they were exceeded by the liberality with which he at once presented to the Government the patent, for which they must have paid almost any sum of money which he liked to demand. He made no stipulations, and when his noble friend at the head of the Government asked him (General Peel) to think of some sum which might be presented to Mr. Armstrong, he was at once relieved from all difficulty by that gentleman proposing to accept a sum of 20,000*l.* spread over 10 years, which should secure to the country his services as consulting engineer of rifled ordnance. For himself, as he had said, he made no stipulations, but for the firm to which he then, but no longer belonged, he made this arrangement, that if they erected extensive buildings for the manufacture of these guns, and did not receive sufficient orders to cover their expenditure, an arbitrator, who should be the Attorney-General of the day, should decide what compensation they should receive from the Government for the capital which they had laid out. He was convinced that the House would be of opinion that nothing could be more liberal than the manner in which Sir W. Armstrong had dealt with the Government; and would think that he well deserved the honour which, by her own special and personal desire, had been conferred upon him by Her Majesty.

Mr. Armstrong, in addition to the honour of knighthood, and the appointment of Superintendent of the Rifled Ordnance Department at Woolwich, received a certificate authorizing the suppression of his patent for the gun. From the inventor's statement it appears that the gun was originally proposed by him, late in 1854, to the Duke of Newcastle, then Minister-at-War, who ordered a field-piece to be constructed in conformity with the plan suggested. The gun was accordingly made, and for nearly two years was the subject of numerous experiments, partly upon the Ordnance Firing-ground at Shoeburyness, but principally under Mr. Armstrong's own superintendence at Newcastle-upon-Tyne. From engravings of its supposed form in the *Mechanics' Magazine*, the Armstrong gun would appear to approach much nearer than any other to the relative proportions of the rifle. In other words, it is long, and, comparatively to its length, of slender calibre. The bore is rifled, so that it is, in fact, to all intents and purposes, an enormous rifle. *Bolts*, properly speaking, rather than bullets, seem to be the missile to be chiefly shot from it, although shell and other forms are also spoken of. The implement is breech-loading. A later note in the *Mechanics' Magazine* states: "We find that in the Armstrong gun, as now made, the large screw at the breech is formed hollow, and the charge is passed into the gun through it. With this arrangement the moveable breech-piece is only required to close the breech, and receive the force of the explosion. Both the slot and the breech-piece are therefore smaller than they would require to be were the gun loaded through the slot." The new cannon will be only one-third the weight of the old, and it is asserted it will literally realize the scouted idea of "the long range." The Armstrong will carry bolts no less than five miles and upwards; and, at shorter distances, its aim is so accurate, that it strikes the object aimed at fifty-seven times for once of the old cannon. The power of artillery will by its aid be multiplied no less than fiftyfold.

The first battery of Armstrong guns, six 12-pound breech-loading rifles, was proved at the Royal Arsenal butt, Woolwich, in preparation for transit to China by the overland route. The proof-charges employed on the occasion consisted of the largest amount of powder with which it was possible to cram the chambers of each gun, and a couple, or double shot. Colonel Tulloh, Mr. Anderson, and Captain Gordon, who were the authorities present, thoroughly tested and searched each gun immediately after the discharge, to ascertain the effect. The terrible shock which the excessive charge produced brought the guns off their position with a perfect leap, and gave a recoil of about 25 feet; nevertheless, the thorough temper of the materials and the remarkable character of the guns nobly resisted the shock. They were accordingly pronounced impossible to burst under fair usage. The *Ariadne* has been armed with Armstrong's guns of the largest calibre, and is the first vessel of her class furnished with this tremendous armament, thus disposed: Twenty-four 84-cwt. guns, each 9 feet 4 inches in length, on the main deck; and on the upper deck will be placed two 68-pounders, each of 95 cwt., and 10 feet 2 inches in length.

Mr. Lynall Thomas, the experienced writer on Gunnery, who has been present, with the consent of Sir W. Armstrong, at several trials of the Armstrong gun at Shoeburyness, remarks on this weapon:—

"The great merit of the Armstrong gun appears to consist in an admirable combination of certain approved principles rather than in the adaptation (except, perhaps, with regard to the manufacture of the gun) of any positively new invention. So happy a combination, however, could only result from numerous experiments conducted by a person possessing great mechanical skill, and a considerable knowledge of the science of gunnery. The chief noticeable points in which this gun differs from those in ordinary use, are the metal of which it is constructed, and the (breech-loading) principle upon which it acts. With regard to the first of these points, the success of the Armstrong gun has placed beyond a doubt the fact that wrought-iron and steel are admirably adapted for the construction of rifled field-pieces and guns of a medium size. This, in itself, is an important fact. The *breech-loading* principle has, I think, but few points to be remarked in its favour, compared with what may be urged against it. In this case, however, the combination by which the efficiency of the projectile is obtained is dependent entirely upon it. The great accuracy and range obtained with the Armstrong gun are startling from their novelty only; for as yet the rifled cannon is but in its infancy; and although the greatest possible praise is due to Sir W. Armstrong for the great ingenuity as well as for the superior mechanical and scientific knowledge which he has displayed in the construction both of his gun and his projectiles, I am nevertheless fully persuaded that equally good results will be obtained with a combination of a much more simple and inexpensive character. Regarding the Armstrong gun as a scientific engine or machine for the projection of an elongated shot, it is a *chef-d'œuvre;* the accuracy obtained with it is remarkable. This is partly due to the delicacy of the *sights* (which are so arranged as to allow for the lateral deflection), and to the absence of all recoil."

Sir William Armstrong, in a speech at Newcastle, has narrated the following interesting facts connected with the trials of his formidable weapon. He said:—

"I could give you hundreds of examples of the effects produced by my shells during the experiments of the 'Committee on Rifled Cannon,' but I will confine myself to a single instance, which I select merely because an unusual number of persons happened to be present, comprising the Duke of Cambridge and several officers of distinction. Two targets, each of 9 feet square, were placed at a distance of 1500 yards from the gun, and 7 shells were fired at them. Now the effect of these 7 shells was, that the 2 targets were struck in 596 places. Similar effects were on other occasions produced at distances extending to 3000 yards; so I leave you to judge what would be the effect of these shells in making an enemy keep his distance. For breaching purposes, or for blowing up buildings, or for ripping a hole in the side of a ship, a different construction of shell is adopted; the object in that case being to introduce the largest possible charge of powder. It has been urged as an objection to my projectile that it would make so small a hole in passing through the side of a ship. So far as the shot is concerned, there may be some reason in this objection, but as regards the shell the small hole is the very thing wanted. The shell is caused to explode at the instant of passing through the timber, and the smaller the hole made by penetration, the more confined will be the explosion, and the greater will be the shattering effect produced. The gun must be judged, not in relation to the shot, but to the shell, which is beyond comparison the more formidable projectile, and which will be almost exclusively used with my guns.

"With respect to the precision and range which has been attained with the rifled cannons I may observe, that at a distance of 600 yards an object no larger than the muzzle of an enemy's gun may be struck at almost every shot. At 3000 yards a target 9 feet square, which at that distance looks like a mere speck, has on a calm day been struck five times in ten shots. A ship would afford a target large enough to be hit at much longer distances, and shells may be thrown into a town or fortress at a range of more than five miles. It is an interesting question to consider what would be the effect of the general introduction of these weapons upon the various conditions of warfare. In the case of ships opposed to ships in the open sea, it appears to me they would simply destroy each other like cats if both were made of timber. The day has gone by for putting men in armour, but I suspect it is only approaching for putting ships in armour. In the case of invasion, which is, perhaps, the most interesting case to consider, the possession of such an artillery would be all-important to the defenders. It would probably be impossible to effect a landing if opposed even by field batteries of such guns; and if a landing were effected, the retreating force would generally be enabled to avail itself of cover, while the attacking party would have to advance on the open, where they would be awfully cut up."

Several inventors have claimed the principal features of the Armstrong gun and projectile, which, it is admitted, are not new. Dr. Smith, at a meeting of the Manchester Literary and Philosophical Society, has stated that the great merit of the new gun consists in the manner in which the internal tube of steel is enveloped with wrought-iron. The difficult problem of forming a perfect compound structure has, however, received solution in the hands of Sir W. Armstrong, while others have failed.

Sir William Armstrong has long been a distinguished inventor, and we have already pointed attention to his hydraulic cranes, and his hydro-electric engine. He practised, till within the last ten or twelve years, as a solicitor at Newcastle-upon-Tyne. Thereafter he became one of the most extensive engineering manufacturers on the Tyne. His partners are employed by the Government in constructing the Armstrong gun, and the extensive Elswick engine-works are to be greatly enlarged for this purpose.

STEAM-HAMMER FOR WOOLWICH ARSENAL.

A GIGANTIC Steam-Hammer, to be employed in the forging of Armstrong guns in Woolwich Arsenal, has been constructed by Messrs. Morrison and Co., of Ouseburn, on the principle of their well-known patent. The hammer-bar and face weigh four tons, and the cylinder in which this bar works, with its glands, nearly six tons. The cylinder is supported on two frames, each of nine tons, and each of these again rests on a bed-plate of the same weight. Through these bed-plates projects the anvil, which is a mass of wrought-iron, faced with steel, and imbedded in a block of cast-iron, weighing upwards of 21 tons. This block was cast on December 24, 1859: about nine in the morning, 25 tons of metal were placed in the cupola furnace of the works; by two the metal was thoroughly fused, and in a quarter of an hour it was run into the mould, with perfect success. The immense block thus formed, measures at the base 6 feet 7 inches by 9 feet 2 inches, and is 4 feet 10 inches in height. The anvil proper is let into the top, the base resting on two layers of heavy logs, about 14 feet square. One of the advantages of this hammer consists in the placing of the cylinder, which is so bolted between the support of the frames, that instead of forcing them asunder, it tends, by its pressure, to keep them more firmly in their places. In the management of the hammer also, great perfection has been attained: it can be made to pound with prodigious force a mass of glowing iron, or to crack a nut in the gentlest manner. The hammer can likewise be worked with great diversity of power; the stroke can be given with a force exactly corresponding with the weight of the hammer; and this force can be diminished at pleasure, or increased by the application of the steam above or below the piston. Its speed can be adapted to almost every variety of work: it can be made to descend like the heavy sledge, or to deliver from 200 to 300 strokes a minute.—*Abridged from the Northern Daily Express.*

THE LANCASTER AND ENFIELD RIFLES COMPARED.

THE important disclosures which have been made public relative to the alleged defects in the Enfield Rifle used by the British troops in India, have been the means of directing the attention of the authorities to the vast superiority, as a weapon in the hands of troops, of the Lancaster rifled carbines, with which the corps of Royal Engineers is now armed. From the Reports which have been received by the authorities at the Horse Guards from the officers who have served with the Royal Engineers in India, there can be no doubt that the Lancaster rifle is in every respect superior to any small arm in the service, repeated proofs of which were given during the conflicts with the mutineers in India. Four companies of the Royal Engineers have been employed in India during the rebellion, all armed with the Lancaster carbine, and the same tests which applied to the Enfield rifle proved it to be defective, have resulted in the Lancaster rifle maintaining its efficiency. The officers report that there has not been a single complaint of fouling, difficulty of loading, or want of accuracy and power, brought against it; but, on the contrary, it has proved, in every respect, superior to the Enfield rifle. During the frequent conflicts with the mutineers, in which the men of the Royal Engineers and the troops of the line were engaged together, with the same amount of ammunition issued to all the troops engaged, the men of the line regiments have been compelled to cease firing for the purpose of wiping out the barrels of their Enfield rifles after firing from 10 to 20 rounds; whereas the Royal Engineers, with the Lancaster rifle, continued their fire, loading their carbines with perfect ease. On the 21st February, 1858, the 4th company of Royal Engineers, consisting of about 100 non-commissioned officers and men, was stationed at Fort Jellalabad, before Lucknow. The enemy attacked the fort in great numbers, and went close to the walls. They were, however, repulsed by the Royal Engineers with great loss, no less than 90 men being left dead on the ground, the whole being killed by the Lancaster rifles. No idea could be formed of the number of killed and wounded carried off, but no doubt it was considerable. The Royal Engineers sustained no loss; not a man was even wounded. This fact is most important, not so much as showing the accuracy of the arm, but from the circumstance that during the six hours the Royal Engineers were engaged with the rebels, until relieved by Sir J. Outram's force, each man fired on an average at least 60 rounds, and yet not the least difficulty was experienced during the whole of that time in loading the carbines. The only thing observable was, that with some the bullet became a little tighter than usual as it approached the breech when rammed down the barrel, and with others that there was an increased recoil. If the defects pointed out in the Enfield rifle and the difficulty with which it is loaded after several rounds have been fired from it, resulted from the expansive action of the barrel against the bands, or against the bayonet socket and its ring, causing an indentation of its outer surface, and consequent contraction of the bore at those places, the defect would be permanent, and nothing but a mandril or cutting tool forced into the barrel could remove it. It is, however, well known that after an Enfield rifle has been wiped out with a wet or greasy rag, it loads as easily and fires as well as when first used, thus proving that the defect alluded to is not a permanent one produced in the metal of the barrel by expansion, but a temporary one resulting from the peculiarity of bore retaining the maximum amount of deposit from the powder charge. On the other hand, the peculiarity of the Lancaster bore, judging from its performance under the same circumstances and with the same ammunition, appears to be such that it retains only the minimum amount of deposit, while at the same time its range and accuracy are greater. In the last-mentioned qualities it has been frequently proved to excel the Enfield rifle in England as well as India. Both rifles may now be considered to have had a fair trial in the very best school for testing their respective merits, namely, actual warfare; and from the unanimous testimony of officers and men, both in India and elsewhere, there can be no doubt that as a weapon in the hands of troops engaged in war, the Lancaster is in every respect superior to the Enfield rifle.

Mr. Lancaster's latest improvement is an admirable breech-loading rifle, of that class in which, when the piece is to be loaded, the barrel is drawn forward from the breech, and turned down, so as to present its rear end to receive the charge. Mr. Lancaster's improvements are four in number. They consist, first, in undercutting the abutment or stationary breech against which the barrels rest when ready for firing, and in cutting the rear of the barrels to correspond, in such manner that when the barrels and breech are in contact, the overhanging part of the breech prevents the rear of the barrels from rising. Secondly, in forming sunken recesses in the inclined face of the breech, to enable the rear end of the cartridges to be supported in their own plane, that is, square to the bore. Thirdly, in fitting the strikers, which carry the points for exploding the cartridges, without springs, the points and strikers being pushed back by the cartridges coming in contact with the points when the rear of the barrels is forced home in the breech. And, fourthly, in constructing the extractor or instrument whereby the cartridges are pushed out from the rear of the barrels when they are tilted preparatory to re-loading, in such manner that it (the extractor) takes the cartridges at two points, and embraces a considerably larger portion of the capsule or rear of the cartridges than heretofore.—*Mechanics' Magazine.*

MAJOR RHODES'S PATENT TENTS.

AMONG the advantages of these improved Tents are — that a hospital tent can be pitched by 8 men in 12 minutes; and, whereas in the present tents there are about 150 pegs and 70 ropes to each, the new invention has only about 40 pegs and 12 ropes to secure it, there being no necessity for the men to turn out in the rain during the night to "slack" the ropes as with the present tents—a serious matter when to be performed by sick patients.

This hospital tent weighs about 112 lbs. less than the Government hospital marquee, and its cost is about 3*l*. under the Government contract price. The ventilation is most efficient, and subject to the control of the medical officer; impervious to wet, and the strong rays of the sun; and can be pitched in 12 minutes by 8 men. The Hanoverian Government (who have practically tested this tent) pronounce that Rhodes's hospital tent affords the best shelter hitherto obtained in camp hospitals, &c. The price of a Government hospital marquee, 30 feet wide by 14½ feet, and 14 feet in height, is from 33*l*. to 35*l*., and weighs (in three packages) from 507 lbs. to 652 lbs. (the latter weight includes 4 ground sheets.) It affords accommodation for from 18 to 20 patients. Major Rhodes's 20-feet diameter field tent costs 24*l*., viz., about 12*l*. cheaper, and weighs (in 2 packages) 230 lbs., viz., 277 lbs. less than the Government hospital marquee. It offers accommodation for from 18 to 20 patients. Two of Major Rhodes's 20-feet diameter field tents can be pitched by 4 men (in about 8 minutes for each tent), on about the same space of ground as is requisite for only one Government hospital marquee; and further, from 10 to 14 men require from 15 to 20 minutes to pitch the latter tent. Major Rhodes's tent provides detached accommodation for 24 rifles, 24 sets of accoutrements, and 24 knapsacks, with a perfect system of ventilation; in which very important points the Government hospital marquee is deficient. Irrespective of cost, &c., it results that by adopting Major Rhodes's tents into the service, healthy shelter can be provided for about 45 men, allowing the same amount of transport as is at present necessary for conveying only one Government hospital marquee, which latter only affords accommodation for 20 men; thus showing a clear saving of more than one hundred per cent. in cost of transport, which, with an army in the field, would be a very great relief to the Commissariat Department.

The canvas of these tents is supported by radial ribs, composed of wood, bamboo, or other suitable flexible material. The base ends of these ribs are forced into the ground, passing through metal rings, secured at equal distances to a series of pieces of galvanized wire (which is an improvement on the endless circumscribing cord or ground rope); this galvanized wire is secured to the ground by tent-pegs. The upper extremities of these ribs are bent inwards, and then inserted within metal sockets (for the field tent, to the central wooden head-piece only) attached to the central wooden head-piece and ridge pole. The improvements in the hospital tent are, that the ridge pole is in one length, jointed at the centre, and secured (when used) by a sliding ferule or cylinder; the ground band is made of a series of galvanized wire lengths, having metal rings attached. Interior and exterior storm ropes are attached, being in direct communication with each other. Rifle loops are secured to the canvas of the tent, whereby two rifles can be supported (together with the accoutrements of two soldiers) at each rib of the tent.

PROPERTIES OF GUNPOWDER.

MR. FAIRBAIRN, F.R.S., has communicated to the Literary and Philosophical Society of Manchester, the following results of "An Experimental Inquiry into the Effect of severe Pressure upon the Properties of Gunpowder." During the late war, the author received from the Government authorities at Woolwich different samples of Waltham Abbey Gunpowder, for the purpose of submitting them to severe compression, in order to ascertain the effect of close contact between the particles upon its explosive properties. At the Government works there is no machinery of sufficient strength to give a pressure of more than 5000 lbs. to 6000 lbs. per square inch, and as it was considered advisable to test the quality of the powder under the influence of greatly increased pressure, the author was requested to compress it in an apparatus of his own, calculated to effect its condensation under a force of more than 60,000 lbs. per square inch. By carrying the pressure in this way far beyond the ordinary limits, it was expected that the precise influence of compression on the properties of the powder would be more clearly and accurately exhibited.

The samples of powder were placed in a wrought-iron box, and compressed by a lever acting upon them by a solid piston with a force varying from 38,000 lbs. to 67,000 lbs. per square inch in the different specimens. When taken from the apparatus, the powder was found to have been consolidated into cylinders of 1¼ inches in diameter with smooth polished surfaces, every trace of its granular character having disappeared.

From the Report of Mr. Abel, the chemist of the War Department, we learn that the specific gravity of the specimens was increased by the pressure, but not to so great an extent as might have been expected.

The specimens having been granulated, were then burned, and it was found, on comparing the results with those of similar experiments on ordinary press-cake, that the amount of residue left by the compressed powders, after ignition, was greater in proportion as the pressure was increased. This increase of residue is probably to be attributed to the more gradual combustion and the diminished intensity of heat generated by compressed powder.

Experiments were then instituted to determine the amount of charcoal left unconsumed in the residue. They showed conclusively that the condensation of the powder had caused a more perfect chemical action in combustion, as the per-centage of carbon was considerably diminished in the compressed powders. Nitric acid was very carefully searched for in the residues of the compressed powders, but none could be detected, although in ordinary gunpowder a portion of the acid of the saltpetre always escapes decomposition.

An important objection to the application of increased pressure in the manufacture of gunpowder, notwithstanding the more intimate mechanical mixture of its constituents, is that the quantity of the residue left after combustion is increased, and a larger proportion of powder escapes ignition altogether when a charge is fired from a gun. If, however, larger quantities were submitted to compression, it is probable that the closer contact of the particles might be found to act beneficially, and a powder be produced of an improved and stronger quality, resulting from a judicious application of increased pressure and a more perfect system of granulation.

Dr. Roscoe expressed his opinion that we as yet know very little about the chemistry of Gunpowder, and drew the attention of the Society to the interesting and important *Memoirs on the Analysis of the Products and Combustion of Gunpowder*, lately published by Professor Bunsen. He found that the decomposition which occurs in an explosion, is by no means as simple as was formerly supposed. Besides the usual products of carbonic acid, carbonic oxide, nitrogen, and sulphide of potassium, Bunsen showed the presence of hydrogen, oxides of nitrogen, cyanide of potassium, sulpho-cyanide of potassium, sulphate and carbonate of potash, and various other salts, the relative quantities of which were all determined.—*Mechanics' Magazine.*

Mr. Lynall Thomas, in a communication to the Royal Society, says:—Since the year 1797, when Count Rumford made his experiments for ascertaining the initial force of fired gunpowder, an account of which appears in the *Philosophical Transactions* of that year, very little light has been thrown on the subject. Count Rumford's experiments, valuable in many respects, afforded indeed nothing conclusive respecting it. The object of the present paper is to show the unsatisfactory nature of the present theory of the action of gunpowder, and to point out some of the principal errors upon which this theory is based. For this purpose, the results of various experiments made by the author, and which were repeated in the presence of a select committee at Woolwich, are described and explained. These experiments are held by the author not only to afford complete evidence of the unsoundness of the present theory, but as sufficiently conclusive to serve as the basis for the formation of a new set of formulæ, both correct and simple, in place of those at present in use. The initial action of the fired charge of powder upon the shot—the first movement of the shot itself in the gun, and the force exerted upon the gun by different charges of powder, and, therefore, the actual strength of metal required by the gun—are circumstances which, as the author believes, have not only been misunderstood, but for which laws have been assigned directly opposed to the truth. As an instance of this, the hitherto received theory supposes that when a shot is forced from a gun it acquires its velocity gradually, from the pressure of the elastic fluid generated by the fired powder acting upon it through a certain space. It is also supposed that the initial pressure of the elastic fluid is the *same* in all cases (the quantities of powder being proportional), whether the gun from which the shot is fired be large or small; so that the larger the calibre of the gun, the slower the first movement of the shot is supposed to be.

The result of the following experiment is given to prove that the first of these propositions is incorrect. The author placed a cast-iron shot, 3 inches in diameter, and 3 lbs. 14 oz. in weight, upon a chamber half an inch in diameter, and half an inch deep. This chamber was formed in a block of gun-metal, and contained, when filled, one dram of powder. Upon lighting the powder, the ball was driven to a height of 5 feet 6 inches; when the ball was placed ⅛th of an inch over the chamber, the charge failed to move it. From this it is inferred that the first force of the powder is an *impulsive* force, that is to say, it imparts to the shot at once a finite velocity. In order to place the matter beyond a doubt, and to ascertain the relative force of different quantities of powder, the author caused a chamber to be made similar in form to, but of twice the linear dimensions of, the former; he then placed a cast-iron ball of 6 inches in diameter upon the orifice of this chamber, which was filled with powder; upon firing the latter, the ball was driven up to a height of 11 feet; that is to say, to double the height of the smaller. The state of the metal in which the chamber was formed also showed the increase of the initial force of the powder; this is considered to be sufficient proof that the last two of the above-mentioned propositions are as incorrect as the first. Assuming the initial force of the powder to be of an impulsive nature, it is not difficult to understand the increase of force shown in the last-named experiment, inasmuch as a certain time being required for the complete conversion of the powder into an elastic fluid, a quantity contained in a chamber of a similar form, but of greater linear dimensions than another, must ignite in a less comparative time, the linear dimensions increasing in the ratio of the first power, and the quantity of powder increasing in the ratio of the third power, so that the flame will traverse a larger quantity in comparatively less time. Thus it appears that the powder which inflames more rapidly has a much greater initial force, being more *concentrated* in its action; a quick burning powder, therefore, is better for ordnance of small length, such as mortars and iron howitzers. The different results produced by powder of different quality have, according to the author, been entirely overlooked in the hitherto received theory. This theory, which considers the *secondary* force, namely, the elasticity of the fluid only, and takes no account whatever of the enormous impulsive or initial force, produced by the sudden conversion of the powder into an elastic fluid, is that which regulates the system upon which ordnance are at present constructed; hence the reason why large guns are so liable to burst—so much so, that it has been said that no gun larger than a 32-pounder is safe to fire.

From the variety of experiments made by the author, he arrives at the conclusion that when powder is of the same quality, and confined in chambers of similar form, but of different sizes, the initial force varies, within certain limits, in the ratio of $\frac{w^{\frac{1}{3}}}{w'}$, where w is the weight of the powder, and w' of the ball. Thus were this new theory recognised, the question of the increase of strength, with increased thickness of metal, would wear an entirely new aspect. So far from the metal in large guns diminishing in strength in the proportion assumed, it will be a matter for inquiry how it resists the great strain to which it is subjected, rather than why it yields; for we find from the experiments described above, that a 68-pounder gun, which has a calibre of twice the diameter of a 9-pounder gun, must, when fired with the same proportionate charge of powder as the latter, continually be subject to as great a strain as the latter would suffer if always fired with the proof-charge, which is three times the quantity of the ordinary service-charge.—*Proc. Royal Soc.*

THE DEEP-SEA PRESSURE GAUGE.

MR. HENRY JOHNSON, the inventor of this instrument, to show the Pressure of Water at various depths, by the compression of an isolated column of air, has read to the British Association the following paper:—The few experiments which I have made on the compressibility of water by pressure, show a greater than indicated by Mr. Carston of 1 in 21,740 for the pressure of one atmosphere. The method adopted is that of subjecting to the pressure of a column of mercury a bulb of water on the short end of an inverted glass syphon, containing eight ounces of water, ninety-nine parts in the bulb and one part in the tube, which is divided into 100 degrees, so that each degree is of the whole 1-10,100th part, and the pressure of each 30 in. of mercury caused a compression of rather more than 1 degree in fresh water, and about ⅘ of a degree in sea water. The result varied a little, owing to the effect of slight variations of temperature on the bulb. This difference of result, however, does not affect the principle of the instrument. The compressibility of water is too minute to be recorded in a simple tube, but it may be recorded in two methods: one, with a bulb or bottle and a tube accurately divided, the tube being furnished with an index to be pushed along the tube by a cork or elastic piston isolating the water in the vessel, and travelling along the tube towards the bulb during the descent until the isolated water became equally dense with the water surrounding it, and when pushed back in ascending by the expanding water in the bottle, leaving behind the index to mark the degree of compression, a small aperture at the end of the scale allowing the escape of the air confined by the cork or elastic piston. The instrument to be fastened to a line with the piston downwards, so that the isolated water, being lighter than surrounding water, should press upwards against the tap rather than towards the piston. Another method of applying the principle has, however, been adopted on the suggestion of Mr. F. Hoffman, who made the instrument; namely, to have a tube or cylinder of metal, and in lieu of a scale tube, to use a long bolt of metal, or, in other words, a long solid metal piston, to enter the cylinder through a packing-box, and to be pressed into the cylinder by the external pressure of the superincumbent water. In descending, the piston, when pressed into the cylinder until the density of the isolated sea water equalled that of the sea water surrounding it, would draw along an external scale an index recording the compression; and on ascending, the piston, when pushed back by the expansion of the isolated water, would leave in its position the index fixed by a spring acting on a toothed rack at the side of the scale. In this form the action of the instrument appears to be very simple—the piston being pressed into the cylinder, or out of it, according to the relatial density of the water in the cylinder and of the water surrounding it; and resembles the action of some other hydraulic presses, although this instrument is worked by the pressure of the sea, and others by the hydraulic pump. After a correction for the effect of the friction upon the piston in the packing-box, and which is considerable, the instrument appears to record the density or compression of the sea water surrounding it; and consequently the pressure to which telegraph lines would be subjected at the same depth.

The vessel is made of cylindrical form in order to allow some length for the piston and scale, and it contains exactly 10 ounces of water. The piston is of such a size that 26 in. would displace one ounce of water, and is divided into 100 principal degrees, which are subdivided, each principal being 1-1000th part. Of this length a portion of 40 deg. (about 10 in.) has been taken, so that this instrument can record compression up to the extent of 40 parts in a thousand. A spanner accompanies the instrument, to unscrew or tighten the packing-box when necessary; the other end of the spanner fits into and turns a tap at one end of the cylinder, the interior of which is oval, and the tap has a small air channel to allow the escape of air, so that the cylinder may be filled quite full of water. The instrument may then be placed in the accompanying stand, and the cross bar screwed on to the piston, and weights attached to the cross bar showing pressure after deducting the weight of the two 2 lb. weights, together 4 lb., which are required to overcome the friction on the piston in the packing-box, when the cylinder is empty. The spring should be relaxed, and the index pressed down a little, and afterwards pushed up to the piston to prevent the friction of the index from affecting the experiment. If the two 5 lb. weights, together 10 lb., are used after deducting the 4 lb. for friction, a pressure weight remains of 6 lb. The diameter of the piston being $\frac{3}{10}$ths of an inch, the area is about $\frac{1}{14}$th part of a square inch, and the pressure of the 6 lb. upon the piston is thus equal to a pressure of 84 lb. per square inch.

It is to be hoped that after some further experiments to ascertain the effect of variation of temperature upon the capacity of the cylinder, and any correction that may be required, that the instrument will be found practically useful.

TENSILE AND COMPRESSIVE STRENGTH OF VARIOUS KINDS OF GLASS.

There has been read to the Royal Society a communication, "On the Resistance of Glass Globes and Cylinders to collapse from External Pressure, and on the Tensile and Comprehensive Strength of various kinds of Glass," by William Fairbairn and T. Tate.

The researches contained in this paper are in continuance of those upon the Resistance of Wrought-Iron Tubes to collapse, which have been published in the *Philosophical Transactions* for 1858.* The results arrived at in these experiments were so important as to suggest further inquiry under the same conditions of rupture with other materials; and glass was selected, not only as differing widely in its physical properties from wrought-iron, and hence well fitted to extend our knowledge of the laws of collapse, but because our acquaintance with its strength in the various forms in which it is employed in the arts and in scientific research is very limited. To arrive at satisfactory conclusions, the experiments on this material were extended so as to embrace the direct tenacity, the resistance to compression, and the resistance to bursting, as well as the resistance to collapse.

The glass experimented upon was of three kinds:—

	Specific gravity.
Best Flint Glass	3·0782
Common Green Glass	2·5284
Extra White Crown Glass	2·4504

Tenacity of Glass.—For reasons detailed by the authors, the experiments upon the direct tenacity of glass made by tearing specimens asunder are less satisfactory than those in the rest of the paper; and it is argued that more reliance is to be placed upon the tenacity deduced from the experiments on the resistance of globes to bursting in which water-pressure was employed, than upon the tenacity obtained directly by tearing specimens asunder. The results obtained by the latter method give the following mean results:—

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* For the previous Report, see *Year-Book of Facts*, 1859, p. 19.

	Tenacity per square inch in pounds.
Flint Glass	2413
Green Glass	2896
Crown Glass	2346

Resistance of Glass to Crushing.—The experiments in this section were made upon small cylinders and cubes of glass crushed between parallel steel surfaces by means of a lever. The cylinders were cut of the required length from rods drawn to the required diameter, when molten, and then annealed, in this way retaining the exterior and first cooled skin of glass. The cubes were cut from much larger portions, and were in consequence probably in a less perfect condition as regards annealing. Hence, as might have been anticipated, the results upon the two classes of specimens, although consistent in each case, differ widely from one another.

The mean compressive resistance of the cylinders, varying in height from 1 to 2 inches, and about 0·75 inch in diameter, is given in the following table:—

Description of Glass.	Height of Cylinder in Inches.	Mean Crushing-weight per Square Inch.		Mean Crushing-weight per Square Inch.	
		In Pounds.	In Tons.	In Pounds.	In Tons.
Flint Glass	1	29,168	13·021	37,582	12·313
	1·5	20,775	9·274		
	2·0	32,803	14·644		
Green Glass	1	22,583	10·081	31,876	14·227
	1·5	35,029	15·628		
	2·0	38,105	16·971		
Crown Glass	1·0	23,181	10·348	31,003	13·840
	1·5	38,825	17·332		

The specimens were crushed almost to powder by the violence of the concussion; it appeared, however, that the fracture occurred in vertical planes, splitting up the specimen in all directions. Cracks were noticed to form some time before the specimen finally gave way; then these rapidly increased in number, splitting the glass into innumerable prisms, which finally bent or broke, and the specimen was destroyed.

The following table gives the results of the experiments upon the cut cubes of glass:—

	Mean Resistance to Crushing.	
	In Pounds.	In Tons.
Flint Glass	13,130	6·861
Green Glass	20,206	9·010
Crown Glass	21,867	9·762

Hence, comparing the results on cylinders with those on cubes, we find a mean superiority in the former case in the ratio of 1·6 : 1, due to the more perfect annealing of the glass.

BORING FOR WATER.

A PAPER has been read to the British Association, "On the Result of Boring for Water in the New Red Sandstone, near Shiffnal, in the County of Salop," by Mr. J. F. Bateman. The supply of water to Wolverhampton being found insufficient, new works have been constructed by the author for bringing the water from the river Worth, nine miles from Wolverhampton and three from Shiffnal. The river Worth, at the place where the pumping-works are erected, is not more than forty or fifty feet above the Severn, which it joins at Bridgwater, eight or ten miles distant. It may, therefore, be considered as the bottom of a basin little above the level of the sea. From the character of the surrounding hills, and the inclination of the beds of new red sandstone, it appeared to the author of the paper likely, that although the wells previously sunk on the high plateau of Wolverhampton had proved comparative failures, a considerable quantity of water might be found in the sandstone at the lower level, and that some might overflow, as an artesian well. A bore-well was accordingly commenced near Shiffnal, 12 inches in diameter, and continued for 70 feet, when it was diminished to 7 inches, and carried down to a total depth of 260 feet from the surface. Water was met with first at a depth of 22 feet, and from that time it arose with increasing supply to the surface, and flowed over as an artesian well, giving a supply in the end of 210,000 gallons daily. Throughout the whole depth of boring the work varied little in character. It was nearly all hard rock, sometimes very hard, with occasional beds of soft stone. For the last 40 feet or so, the soft beds were thicker; but otherwise there was little change from top to bottom. As the whole well is charged with water to the level of the river, which forms its natural outlet, and as the boring shows that the lower beds receive their supplies from distant sources, the supply may reasonably be expected to be inexhaustible within the limits of that which is due to the percolation of the rain upon the collecting area.

THE GOVERNMENT WATERWORKS, TRAFALGAR-SQUARE.

A PAPER was read in November last at the Institution of Civil Engineers, "On the Origin, Progress, and Present State of the Government Waterworks, Trafalgar-square: with a few facts relating to other Wells which have been sunk, or bored into the chalk formation," by Mr. C. E. Amos, civil engineer. The author commenced by stating that a good supply of water having been required for the fountains in Trafalgar-square, it was determined, in the year 1843, to carry out a plan which had been suggested by Mr. James Easton. This was so framed as to include the water supply for the public offices. The water was to be obtained and raised by engine power, from the springs beneath the London clay. The quantity of water required for condensing the steam of the engine being too great to be taken from the main spring, in full quantity, it was considered expedient to use cooling ponds; and it was thought that a small quantity of water in excess of that required for the public offices, running continually into the cooling ponds, would keep the water clean, and in a state fit for the purpose of condensation. The basins of the fountains were intended to form the cooling ponds. The water from them was to be taken for the use of the condenser, afterwards to be raised into a cistern, from whence it was to be conveyed to, and be passed through the jets of the fountains, where, meeting with the resistance of the air, it would be partially cooled and returned to the basin, for further circulation. Estimates having been made, it was found that the yearly interest on the cost of erection, added to the cost of working, would be less than the sums hitherto paid annually for the water supply to the public offices, and that, consequently, the playing of the fountains could be effected without cost to the Government.

A contract was then made with Messrs. Easton and Amos for the execution of the works, and a piece of ground having been selected in Orange-street, the works were commenced in January, 1844, by sinking the first well to the depth of 174 feet. A cast-iron pipe, 15 inches diameter, was then driven through 30 feet of plastic clay and 10 feet into a stratum of gravel, sand, and stones, being left standing several feet up in the well. Within this another pipe of 7 inches diameter was driven through 35 feet of green-coloured sand, and 3 feet into the chalk formation, and the boring was then continued to the total depth of 300 feet from the surface. A considerable quantity of water came from the sand, but a much larger supply was obtained from the chalk. A second well was sunk in the enclosure immediately in front of the National Gallery, to a depth of 168 feet from the surface. A pipe 14 inches diameter was then driven through the plastic clay, and into the gravel, sand, and stones beneath it. Within this a pipe 7 inches diameter was driven through 42 feet of green-coloured sand, and 3 feet into the chalk, the boring being continued to the total depth of 383 feet. The springs were found to be stronger than those in the well in Orange-street. A tunnel 6 feet in diameter, and about 400 feet long, was driven to connect the two wells; the bottom of it being about 123 feet below T.H.W.M. A catch well 5 feet 6 inches diameter and 32 feet deep was sunk just outside the engine-house. A tunnel was driven from it, passing beneath Castle-street and the National Gallery, to contain the pipes for bringing the water back from the basins of the fountains to the catch well.

The paper then proceeded to describe the situation of the different tanks, or reservoirs, in the water tower, and their purpose; and next gave a brief account of the high-pressure condensing steam-engine, on the Cornish principle, for working two sets of pumps, one being capable of raising one hundred gallons of water per minute from the springs to the tank, and the other five hundred and fifty gallons per minute from the catch well into the tank for condensation and for the supply of the fountains. An auxiliary high-pressure single-acting steam-engine was also provided, to be used when the principal machine needed repair. The works were finished in December, 1844. Their total cost, as completed, amounted to nearly 8400*l*. The water rose to within 90 feet of the surface (about 48 feet below T.H.W.M.), and was found to be of good quality. When the engine was pumping one hundred and ten gallons of water per minute, it could only lower the water 4 feet in the well. In 1846, a further demand for water having been made, a larger pump was substituted, which was capable of raising three hundred and fifty gallons of water per minute from the springs. In 1849, a second well was sunk in Orange-street, and an engine of 60 H.P., on Woolf's principle, was erected. The well was carried to a depth of 176 feet, and a tunnel was driven to connect it with the other wells. A bore pipe was driven through the plastic clay, within which it was intended to drive a smaller pipe through the sand into the chalk, and then to continue the boring as in the other wells. But an accident having occurred in driving the large pipe, which allowed sand to come up the bore hole, and made the water foul, the hole was stopped with bags of clay, and no further use had been made of it, than as a sump-well to contain the pumps. The accident was accounted for in this way:—In driving the pipe great resistance was offered by the "hugging" of the plastic clay, and considerable percussive force had to be used. In consequence several of the screws which held the joints were shaken out, and the pipe having been improperly driven through the layer of gravel, sand, and stones, into the sand beneath, there was an escape of water through the screw-holes, and sand followed in sufficient quantity to cause inconvenience. The steam-engine worked one double-acting pump for supplying the fountains, and two other pumps for raising water from the springs into the tanks above the building. At an average speed of sixteen strokes per minute, the first could throw six hundred and sixty gallons, and the other two together six hundred gallons per minute. This engine is the one now mainly used. The supply of water from the springs was still found to be abundant. The pumping of six hundred gallons per minute lowered the water from 20 feet to 24 feet, when it remained stationary as long as the engine was kept working. The level of the water did not appear to be gradually lowering, and it was stated that on December 1st, 1858, it rose to within 66 feet of T.H.W.M., being about the same level as it stood in December, 1847.

The author thought there could be no doubt that the greater portion of the water was obtained from the chalk. He then referred to the fact of the towns of Brighton, Croydon, Deal, Epsom, Ramsgate, and Woolwich, being all supplied with water from the chalk formation. There was an uncertainty, however, of obtaining a good supply from the chalk, as was illustrated in the case of the well sunk at Messrs. Truman's brewery. In 1857, a greater supply of water being required by the Messrs. Truman, it was determined to extend the works. In the first place the sand and water above the chalk were shut out, then the well was continued to a depth of 300 feet from the top, when it was discontinued, as no water came up the well-hole. As the chalk showed indications of water at the depth of 285 feet, the floor of the tunnels was commenced at that level. These tunnels were 5 feet 6 inches high by 4 feet wide; that on the north side was driven to a length of 57 feet, and that on the south side to 48 feet. The quantity of water now obtained did not exceed twelve and a half gallons per minute. The water of the springs in the sand had been taken by tapping the cylinders at the bottom, instead of, as hitherto, near the top of the sand stratum. A well sunk at Messrs. Combe's brewery, to a depth of about 48 feet into the chalk, produced a supply of seventy gallons per minute. The water stood 20 feet higher in this well than in the Trafalgar-square well, while the water in both wells was in a state of rest.

CLEANSING THE THAMES.

FROM a return issued to an order of the House of Commons we learn that between the 10th of April and the 9th of July, 1859—a period of three months—there were poured into the principal metropolitan sewers and sluices discharging themselves into the Thames 94 tons and 7 quarters of chloride of lime, 185 yards of chalk lime ground, and 2778 yards and 11 bushels of chalk lime, at a total cost of close upon 3000*l.* for labour and materials, but exclusive of the necessary water supply. In 1858 and a half of 1859, the Chelsea Waterworks Company "delivered," daily, from upwards of 6,000,000 gallons to upwards of 7,000,000 gallons; the East London Waterworks from 100,000,000 to 123,000,000 gallons weekly; the Kent Waterworks from 2,753,000 to 3,870,000 gallons daily; the Lambeth Waterworks between 6,000,000 and 7,000,000 gallons daily; the New River Company, in 1858, 20,877,598 gallons daily on an average, and, in 1859, 20,220,915 gallons daily; the Southwark and Vauxhall Water Company upwards of 10,000,000 gallons daily; and the West Middlesex Waterworks Company between 5,000,000 and 7,000,000 gallons daily.

The total quantity of disinfectant agents used during the season was about 4281 tons of chalk lime, 478 tons of chloride of lime, and 56 tons of carbolic acid, at a cost of 17,733*l.*

PURIFICATION OF THE SERPENTINE.

A PLAN proposed by Mr. Hawkesley, and adopted by the Hon. Mr. Fitzroy, for Improving the Condition of the Serpentine, appears to have met with unqualified disapprobation from the public journals and the greater portion of the engineering profession. On the other side, however, we have the names of Mr. Robert Stephenson and Mr. T. Spencer; and the analytical experiments of the latter gentleman are certainly not without weight in favour of Mr. Hawkesley's scheme. This scheme consists in drawing about 2,000,000 gallons of water daily from the lower end of the lake, and throwing the same, when freed from mechanical impurities, into the upper end in the form of a cascade. The effect of this flow of aërated water would be to oxidize the soluble organic matter that nourishes the growth of the *confervæ* and slimy vegetation, which are so detrimental to the appearance of our ornamental sheets of water. It is not, therefore, upon the filtering process alone that we are to depend for the removal of objectionable impurities, and for the attainment of a comparative degree of limpidity. The stagnant vegetation is to be attacked both by natural and by artificial means; since the former cannot wholly be adopted. The importance of the "cascade" during the prevalence of close and dry weather is not easily to be overrated. The chemist can testify to the danger which would be incurred, even in the absence of sulphur and phosphorus from the dissolved organic matter, by removing the living vegetations in whose growth this is absorbed, without at the same time supplying nature's great purifier, oxygen, to obviate chemical changes of a more dangerous character than the conversion of this organic matter into carbonic acid gas. And although it may be observed that this gas is one of the principal supporters of vegetable life, yet the plants which thrive in aërated water are of a very different class to those which grow so freely in a semi-putrid and stagnant compound of decayed vegetable and animal matter.

The necessity both of filtration and aëration is strongly exemplified in the present condition of the lake in St. James's Park. The process there adopted is characterized by a *Times* correspondent, who so strongly repudiates Mr. Hawkesley's plan, as a "complete success." But surely this gentleman cannot himself have verified the condition of this piece of water, or the expressions "clear" and "limpid" must be intended as ironical. The question of their applicability may be left to any inquirer who has an opportunity of viewing the result of the experiment by which this lake has been rendered so completely artificial. Unless much wind or rain shall have intervened, they will find the greater part of it covered with a thick and apparently solid slime—a crust supporting multitudinous light bodies; while throughout its whole extent, the flocculent *confervæ* arrest the sun's rays before their warmth can be absorbed by the solid concrete below. Upon this concrete the vegetations will ultimately be deposited in the form of mud.

Much stress is laid by the advocates of the system adopted by Messrs. Easton, Amos, and Co., in the St. James's Park water, upon the nuisance likely to arise from the filtering apparatus to be established at the upper end of the Serpentine. But if any such nuisance occurs, it must be from gross negligence or want of skill. The matters to be separated are neither poisonous nor rapidly putrescent. The mud at the bottom of the Serpentine is, as we are assured by Mr. Spencer, very different from the Thames slime, the offensiveness of which is owing to a black substance composed of sulphur, carbon, and iron, of which no trace is found in the lake. Choleic acid from bile, and sulphuretted hydrogen evolved from sewage matter, are also absent. Indeed, the impurity of the Serpentine water has been much exaggerated, despite the occasional overflow into it of the contents of the Ranelagh sewer—evidenced at rare intervals by the presence of *paramecia* and *vibriones*. Its offensiveness is simply that of ordinary stagnant water, arising from decaying vegetation, and is far more perceptible to the eye than to the organ of smell. To remove this water, amounting to 60,000,000 of gallons, and to replace it by a similar quantity exposed to the same conditions of stagnation, would be an evident absurdity: and the formation of a shallow artificial bottom of concrete is, in our opinion, not likely to improve its quality. The depth of water in the Serpentine is an advantage the result of which in preventing the most objectionable forms of vegetation has been generally overlooked; and the carbonaceous bottom would probably be but ill replaced by a concrete, the deposit upon which would ferment in the direct rays of the sun.

With regard to the filtering process it may be observed that the method to be adopted will be similar to that in use at the Glasgow Gorbals Waterworks, and other establishments of the same nature. The simplicity and efficacy of this method have been fully tested. The water is discharged from the conduit on the top of a compartment of gravel, through which, by means of an aperture at the bottom, it passes into a well adjoining. The overflow from this then runs into coarse sand, and in a similar manner into fine sand, before it is ultimately discharged. In the case in point there will, for convenience of cleansing, be two such filtering contrivances; and one or more of the stages of purification may probably be dispensed with.

To remove the impression which appears to prevail that the water in the Serpentine approximates in its characters to that of the Thames, it would suffice to examine comparatively the deposits of lime on the margin of the lake and on the banks of the river. That from the latter will be found soon to evolve its noxious constituents; while the lime deposit from the Serpentine is wholly inoffensive. In both cases the addition of lime is of very questionable utility. In the Serpentine especially, though it destroys the *confervæ*, together with the animalcules and the fishes, it cannot prevent their putrefaction, or remove its products. When the plan of Mr. Hawkesley shall have been carried out, we hope that these organisms will be left to fulfil, under more favourable conditions, their due purposes in the economy of nature, and that the Serpentine, when re-stocked with fish, may afford, as of old, a harmless amusement to the piscatorial enthusiasts of London.—*Mechanics' Magazine*, August 26, 1859.

SUBMARINE LAMP.

THE Submarine Lamp is intended by Mr. Rettie, its inventor, chiefly for using under water, for throwing light upon objects in the beds of rivers, or in the depths of the sea, applicable for the examination of the foundation of piers and bridges, and of the hulls of vessels while afloat, also for the purpose of attracting fishes and other residents in the deep, &c.

In the construction of the submarine lamp various points had to be attended to, as essential to its success.

1. The obtaining of a powerful light by a lamp of limited dimensions and perfectly water-tight.
2. Whilst adapted for using near the surface, to be capable of extending with facility, and of strength sufficient to sustain the pressure of water, when immersed to any considerable depth.
3. The entire removal of air vitiated by the flame, and introduction of air capable of supporting combustion.

These having been severally attended to, the object has been satisfactorily attained by the lamp shown.

The lamp may be made either of a globular or cylindrical form (if the former it will require to be of glass), the bottom being made of brass, with a large screwed opening for the admission of the argand burner used; on the top of the globe is a brass cap, into which is screwed a strong copper tube, in the centre of which is fixed another tube, one-fourth less in diameter, and so fixed that air may pass freely in the space between the two; the lower end of this inner tube has a trumpet-shaped termination which enters into the globe, reaching within two inches of the top of the chimney of the argand burner of the lamp. The upper ends of the tubes terminate in a sort of lantern top, which is divided into a lower and upper compartment; from the lower compartment, the larger (or upper) tube conveys the air required by the lamp for effecting combustion, while through the upper compartment is discharged by the inner or centre tube the vitiated air, as ejected from the lamp.

The principle on which the lamp is constructed and depends for action is that arising from the discrepancy of the gravity of the two columns of air necessarily engaged, viz., the column of cold for supplying combustion, and the column of heated air ejected. And in the arrangement of the tubes, advantage is taken to foster the peculiar qualities of the respective columns; thus, the cold being made to descend by the larger and outer tube, whose surface is exposed to the action of the water, while the heated or centre column is placed immediately over the powerful burner of the lamp.—*Proc. Brit.*

SUBMARINE BOAT.

AN experiment has been made at New Castle, Delaware, with a Submarine Salvage Boat, invented by Mr. Villeroi, who descends to the bottom of the river without any arrangement for receiving a supply of fresh air from above, the boat being intended to supply itself with the quantity of air needed while under water, enabling it to remain submerged for any length of time required. Eight men went down in the boat, and remained there an hour and three-quarters without any communication from above. The mode of generating air to supply the boat is yet a secret. The boat is made of boiler iron, and is perfectly round, and shaped somewhat like a fish. It is 35 feet long, 44 inches in diameter, and propelled by a screw 3 feet in diameter. It has two rows of bull's-eyes on the top, for the purpose of giving light to the interior. On each side, near the bow or head, are placed pieces of iron about 18 inches square, which are moved like the fins of a fish, and are intended to direct the boat up or down when under the water.—*Philadelphia Ledger.*

SUBMARINE WORK.

MR. W. E. NEWTON has patented apparatus for facilitating Submarine Explorations, consisting of a working chamber supplied with compressed air from a reservoir, by which also the workmen regulate the buoyant power of the apparatus. Connected with it is a ballast chamber, and a pump communicating with the reservoir of compressed air by the eduction-pipe and by a flexible induction-pipe with the atmosphere above the surface.

PILING AND COFFER-DAMS.

MR. F. W. BRYANT has read to the Society of Engineers a paper "On Piling and Coffer-dams." The author commenced the paper with a sketch of the history of pile-driving from the earliest ages, urging the value of piling for foundations, and mentioning different structures which had given way in consequence of its non-adoption—Westminster-bridge for example. He proceeded with remarks on the woods used, and the attacks of the *Teredo navalis*, or pile-worm, asserting creosote to be an effectual remedy against them, giving proofs of the assertion. He then pointed out the importance of shoeing piles well, and gave the weights of those used in some of the principal works in England. He next described the various kinds of piling-engines that had been employed—mentioning the application of horses for raising the ram—and considered the ordinary crab-engine now generally adopted to be far superior to any of those used formerly. Pile-driving by steam-power was next treated of, the author describing some of the principal machines which have been invented, preferring Sisson and White's, as being the most economical and practically useful. The weights of rams was the next subject—the author noticing the great increase in the weights used at the present day compared with those formerly employed.

Iron pile and plate driving, with the comparatively recent introduction of them, was referred to, and a description of those used at the Westminster New Bridge, and the method of driving them.

BLASTING ROCK.

SOME experiments have been made, attended, it is said, with perfect success, at Fécamp, in Blasting Rock under water for the harbour piers. In order to deepen the channel it was necessary to clear away a portion of excessively hard rock, upon which ordinary implements had but little effect: moreover, the sea never receding entirely from the rock, the means resorted to at first were attended with extreme difficulty, while the operations proved a great impediment to the navigation. At present, with the aid of an electric battery, the rock is being removed with comparative ease, by a contrivance as follows:—Glass jars, containing each fifty kilogrammes of blasting powder, are made watertight by means of corks, through which insulated wires are passed and put in communication with the powder. These vessels are well caulked or sealed, and packed in a basket, with hay, to prevent their being broken against the rock when they are let down. At the moment of high water these "cartouches" are cast into the water, and kept in communication with the electric battery, by means of wires covered with gutta-percha in the usual manner. On the circuit being completed by joining the wires on shore at the northern jetty, the powder ignites, and the elastic gases, finding such enormous resistance in the weight of the water above, strike upon the rock and shiver it to atoms. At each explosion the water rises in a conical form of greater or less height, according to the effect produced on the rock, boils up for a few moments, and in five minutes resumes its usual undulations, leaving no visible traces of the agency exerted below. The *débris* of rock will have to be removed afterwards by dragging, &c., at a slight cost.—*Builder*, No. 839.

THE CLEARING OF DRAINS AND WATER-COURSES.

MESSRS. EASTON AND AMOS, of Southwark, have patented a curious method of adapting to some convenient part of a drain, sewer, or water-course, a grating of peculiar construction, whereby any extraneous solid matters, such as weeds, pieces of wood, brickbats, stones, the dead bodies of animals, or other substances, may be arrested in their progress, and removed, so as to prevent them from blocking up the water-course, and stopping the flow of the water. To this end a chamber or recess is constructed at some convenient part of the drain, sewer, or water-course, and made to extend across it from side to side. In this chamber is mounted a moveable grating in such a manner as to extend transversely across the whole of the water-way. The grating is to be formed of a suitable number of endless chains, connected together laterally in any convenient manner, and provided with projecting pins, points, or hooks. Or a number of short bars similarly provided with projecting pins may be jointed together in an endless series, so as to form an endless grating, which is to be passed round wheels or rollers mounted in the chamber or recess. This endless chain or grating should not be placed vertically, but at an inclination to the line of the drain or sewer. It will be understood that the water and liquid matters will pass freely through the endless chain or grating, but that solid matters of any great size or dimensions, or that would be likely to cause an obstruction in the water-course, will be arrested by the grating, and by causing the same to rotate (by communicating motion to the wheels or rollers on which the endless chain or grating is mounted) the pins, points, or hooks attached to the grating will be caused to lift up such solid matters out of the chamber formed in the drain, and deposit them in some receptacle provided above for that purpose.

LIGHTHOUSES AND BEACONS.

MR. R. ROBERTS has described to the Manchester Philosophical Society his proposed Improvements in Pharology. After adverting to the remarkable fact that the great majority of wrecks and collisions occurred in the immediate vicinity of the beacons intended to guard against them, Mr. Roberts said the idea had occurred to him that the principle of gyration might be advantageously employed to neutralize the action which the wind and waves exert upon floating-light ships.

After briefly describing the principal features of the catoptric and dioptric systems, Mr. Roberts stated that the latter was inapplicable to floating-beacons, owing to their great oscillation, and that they were, therefore, still furnished with 12-inch reflectors, whose power was comparatively small. He felt convinced, however, that the more fully the system of Mons. Fresnel became understood, the more certainly would it be preferred to the catoptric system.

It was, however, essential to the adoption of this system, that the light apparatus be kept upright and free from oscillation, to attain which desideratum Mr. Roberts proposed entirely to change the form of the vessel, making that portion of it which was immersed hemispherical, and that which was above water the frustrum of an inverted cone.

In the centre of this float Mr. Roberts proposed to build a tower (whose lower end should project through the bottom of the float to serve as a keel), carrying a lantern as in shore lighthouses, and containing the necessary accommodation for the light keepers: and within this lantern he proposed to place a dioptric apparatus of the second power, whose light being placed 45 feet above the water-line, might be seen at a distance of nine miles. Immediately below the light apparatus he would place a fly-wheel suitably mounted on gimbals, and driven through the medium of certain wheels and shafts by a small engine, which, with its boilers, would be placed on the third deck of the float, or this wheel might be caused to revolve at its proper speed by two relays, each of three men. The engines and steam might be used for a variety of purposes, as to sound bells or whistles, hoist coals aboard, prevent the adhesion of snow to the lantern, &c.—*Builder,* No. 844.

WATER IN LIGHTHOUSES.

FARADAY has addressed to the *Times* the following letter:—

"The Trinity House, in its care for the health of the people engaged under it in the superintendence of lighthouses, has, at different times, sent to me, as its scientific adviser, certain specimens of Waters, which were supposed to be injurious to the persons using them. Lighthouses are, of necessity, often placed in situations where water is obtained with difficulty, and they are frequently dependent, more or less, upon that which is gathered from rain falling upon the leaden roofs, galleries, and gutters of the towers and cottages occupied by the keepers. Now, the salt of the sea spray, which often reaches these roofs, &c., even when they are half a mile or more from the shore, causes the rain-water which falls upon them to dissolve a portion of the lead, which is larger or smaller under different circumstances, and at times rises up to a quantity injurious to health and poisonous. The water thus contaminated by lead, or rather chloride of lead, is peculiar in this, that it does not lose the poisoning substance either by boiling or by exposure to air, for the metal remains soluble after one or both of these processes. I ascertained that if a little whiting, or pulverized chalk (carbonate of lime), were added to such water, and the whole shaken or stirred together, the lead immediately assumed the insoluble state; so that when the water was either filtered or left to settle, the clear fluid was obtained in a perfectly pure and salubrious condition. The process of purification is, therefore, exceedingly simple, for if some powdered chalk or whiting is put into the cistern in which such rain-water is collected, and stirred up occasionally after rain, the water may, with the greatest facility, be obtained in a perfectly fit state for all culinary and domestic purposes.

"The Trinity House has supplied this information to all the cases needing it which have come to its knowledge, but I find that some cases occur not under its charge, that there are others not connected with lighthouses, and others again in other countries, in all of which this piece of simple practical knowledge may be useful. Under these circumstances I have thought that you, Sir, would not refuse the service of that special and extensive power of publication and instruction which the *Times* possesses, but use it to carry this knowledge to the many dispersed persons who may greatly need and yet have no other means of obtaining it."

BREAKWATERS FOR HARBOURS.

MR. C. BURN, C.E., proposes, in a work published by him, a method by which, as he maintains, a Breakwater for such a site as that of the Dover Harbour of Refuge could be made in one-seventh of the time, and at less than one-half the cost of that now in progress.

"We propose," he remarks, "to construct the breakwater by a series of isolated circular towers, 50 feet in diameter and 70 feet high, constructed entirely of brickwork, concrete, and masonry; the towers to be built at intervals varying from 5 to 15 feet, connected on the top only by an iron gangway and parapet.

"As a means for practically carrying out such a principle of breakwater, we propose to adopt Bentham and Ashton's system of construction.

"The foundation of each tower, or that portion from the bottom up to five feet above low-water mark, is a casing, constructed of brickwork in cement with a granite ashlar facing, forming a circular wall five feet in thickness. This hollow casing or cylinder is built upon a timber platform, calked water-tight, and made sufficiently strong to withstand the pressure of water when the casing is sunk to its floating level.

"The hollow foundations may be towed to their position in the line of breakwater, and when in position, a valve in the timber platform can be opened, the water let in, and they will sink in position and become fixed.

"The centre portion can then be filled in with concrete.

"Having thus made the foundation to a height of five feet above low-water, the superstructure above that point can be constructed in the ordinary manner, with concrete blocks for hearting and granite blocks for facing. The top to be paved with granite blocks or Portland stone.

"Those towers may then be connected together by a cast-iron gangway and parapet."

Such is a brief outline of the plan. The breakwater, instead of being a continuous structure as at present, would be composed of a series of disconnected towers, averaging 10 feet apart. This reduces the quantity of material, it is said, nearly one-fourth, though equally strong and durable as if solid; and will break the force of the waves, and cause still water in the harbour as efficiently as a continuous breakwater. No coffer-dams, of course, will be necessary in constructing such foundations as those described.

HYDRAULIC LIFT AT THE VICTORIA DOCKS.

THIS new Lift, the invention of Mr. Edwin Clark, is in successful operation at the Victoria Docks for ship-lifting, and appears likely to supersede the graving dock for many purposes. Mr. Clark's apparatus consists of a series of thirty-two upright hydraulic rams, of 10 inches in diameter, placed in a waterway in two lines of sixteen each, far enough apart to admit of a ship of any burden passing between. Each ram is fitted with a crosshead of wrought-iron, and the crossheads are supplied with long straps, to the lower end of which are connected girders extending across from row to row. These girders, when the rams are down, are of course at the bottom of the water. The pontoon, on which the ship is raised, is formed of wrought-iron plate, strongly ribbed, the length and depth of which varies according to the size of the ship it is intended to lift. This pontoon is open at the top, and is of sufficient buoyancy, when empty, to support a vessel of very large tonnage. It is fitted with screw valves for admitting the water, so that in a very short time, when placed in position, it can be lowered down upon the cross girders. The rams are fed by a 50 lb. engine, which is fitted with twelve hydraulic pumps, 1⅞th inch in diameter, and 2 feet stroke, working at 18 strokes per minute, and the pipes from these pumps, before branching off to the rams, communicate with a series of valves arranged in a place built for that purpose close to the lift. By means of excentrics, which close the valves, any one of the rams can be disconnected at will from the supply, so that should one of the pipes burst, no danger can accrue to the ship, and the lifting process can be completed without delay.

In an experiment on the 27th of July, the pontoon being placed in position upon the girders, it was first filled and then lowered to the bottom of the water. After this the *Jason*, a ship of about 1000 tons burden, was warped in, and having been fixed in position by means of ten sliding blocks, which were pulled into contact with the sides and bottom by means of chains brought above the water-line, the engine was set to work, and the whole mass rose gradually out of the water at a speed of one foot in three minutes. As the pontoon came above the surface, it relieved itself of the water it contained, and the valves being then closed, the buoyancy of the saucer itself supported the ship in a perfectly steady and satisfactory manner. The whole operation, from the beginning to the end, extended over the space of 1½ hours, and the dead weight lifted, including the pontoon, was altogether above 1600 tons. There are four pontoons constructed, and others in course of construction, which when raised in this manner, and floated, are to be towed with their burden into shallow bricked recesses provided for that purpose, so that the hydraulic power can be continuously applied for raising purposes. During an entertainment which followed the experiment, or rather the operation, Mr. Edwin Clark laid before his audience a clear and concise description of his invention, and the obstacles he had had to contend with in bringing it to its present state of perfection.—*Mechanics' Magazine.*

An important paper descriptive of the Entrance, Entrance Lock, and Jetty Walls, with the Wrought-Iron Gates and Caissons, of the Victoria Docks, has been communicated to the Institution of Civil Engineers, by Mr. W. J. Kingsbury, for which we regret not to be able to find space.

SIR W. G. ARMSTRONG'S HYDRAULIC MACHINERY AT SWANSEA.

THE whole extent of the new docks at Swansea, as well as the river float, is furnished with Sir William Armstrong's Hydraulic Apparatus, which opens the gates, swings the bridges, works the sluices, lifts the hoists, and goes through all manner of operations. The extent of pipes is a mile and a half, and the pressure upon them is 700 lb. to the square inch. The hydraulic power is available for any purpose for which it may be required at any point throughout the entire length of the pipes. The ponderous dock-gates were opened by Miss Talbot, the daughter of the lord-lieutenant, not figuratively, as is usually the case with ceremonial "openings" of this kind, but, thanks to the invention of Sir William Armstrong, literally opened by the delicately-gloved hand of a young lady of eighteen, grasping the capstan, boasting for the nonce a silver handle.

THE FLOATING DERRICK.*

IN August last, the small Derrick belonging to the Patent Derrick Company was employed to raise on board the *Great Eastern* the whole of the ship's yards and her principal gaffs. These spars, constructed by Messrs. Ferguson, of Mill-wall, are the largest of their respective kinds ever made on the Thames or elsewhere. The main-yards average 124 feet in length, are 33 inches in diameter at their centres, and weigh from 15 to 17 tons each. By means of the remarkable facilities which the patent derrick affords, these enormous spars were all hoisted to the required position, on board the *Great Eastern*, during the brief space of a single day. The operations, so far as regarded the great ship, were conducted by Mr. Westhorpe, to whom the rigging of the vessel is intrusted; while the direction of the derrick's hoisting powers was expressly undertaken on this occasion by Mr. A. D. Bishop, the inventor of the machine. The time occupied by the derrick in hoisting the principal main yard to the height of nearly 80 feet, after the operation of slinging had been accomplished, was less than two minutes. The novel application of the principle of the lever, introduced by the inventor of the derrick, enables the machinery while raising its weight simultaneously to run it in or out, backwards or forwards, to any desired point. By this contrivance the derrick was enabled not only to hoist the yards over the ship's side, but also to span the *Great Eastern's* deck amidships and hand her yards direct to the purchases rigged on board the vessel to receive them—a feat which neither crane nor shears on the Thames could accomplish.—*Daily News*.

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* The Derrick is fully described in the *Year-Book of Facts*, 1859, p. 44.

IMPROVED CRAB.

Mr. Denison, Q.C., has exhibited to the Institution of Civil Engineers a small Crab, or Winch, capable of lifting half a ton with a single pulley, although light enough to be carried in one hand. It had two short barrels with five grooves in them for the rope, and a wheel at the end of each barrel, both of which were driven by equal pinions on the winding arbor. The rope passed from one barrel to the other; and the loose end was either pulled off by hand, or fell by its own weight, or by the weight of the descending blocks or empty bucket attached to it, if the crab was worked alternately, like buckets in a well.

Several members stated that the machine was a very good one, but that it had been invented long ago, and was now in use in many factories. To this it was replied, that it was surprising that so valuable an improvement of such a clumsy machine as the common long-barrelled crab should have been unknown to the various engineers, builders, and other persons conversant with such matters, to whom it had been shown or described. It was found that the time spent in fleeting the chain was a quarter of the time spent in actually lifting the Westminster bell to the top of the tower, and two crabs were used for it; whereas, with one such machine as this, it could have been lifted the whole 201 feet without any interruption. The object in bringing the machine to the Institution was to make it generally known, and to show its convenience.

BAINES'S PATENT HOIST-GOVERNOR.

THE primary object of this invention has been to render the lifting apparatus, used in mills, warehouses, and mines, known as the "Hoist-box," its own Governor or regulator; thereby securing the impossibility of a recurrence of those accidents which have from time to time resulted in coal pits and factories, from negligence of the attendant, or weakness of the materials. Attached to the top of the "hoist-box" is a governor or speed regulator, precisely like that used in the ordinary steam-engine. The balls of the regulator acquire centrifugal force through the momentum imparted by a driving band, which is passed over a friction-roller that constantly rests against the side of the shaft or well-hole to be ascended or descended. At each corner of the "hoist-box" is a cam, or excentric, keyed in pairs upon the shafts, to which instantaneous motion is given by the governor, should a rope break or any other accident whatever occur. The consequence is, that these cams are made to clutch the sides or guides of the well-hole with such tremendous force that the box, however heavily loaded, is brought to an immediate stand-still; and even if the speed to which the governor has been adjusted should be exceeded, the friction-roller immediately imparts an accelerated motion to the governing apparatus, which disengages a trigger and prevents the box from descending—let what will occur to engines, ropes, wheels, or gearing—at a quicker speed than that to which the box has been restricted by the application of this ingenious "hoist-governor."—*Builder*, No. 837.

STRAIGHTENING A CHIMNEY-STACK.

THIS operation for restoring the colossal Chimney at Port Dundas to a perpendicular and safe position has been successfully completed. This was accomplished by sawing several of the mortar beds between the courses on the side from which the chimney leaned, thereby allowing it to come back by its own weight, without the application of any external force. Only one draft was cut at a time, to guard against any shock which might have endangered the stability of the building, and by keeping the saws wet, a bed of mortar was prepared for the superincumbent weight to settle down upon. Twelve cuts were made in this manner, on different parts of the structure, which generally set before the saws had passed through half of the circumference, particularly in those made nearest the ground, where the weight was greatest. Mr. Duncan Macfarlane, architect, by whose advice this method was adopted, superintended the undertaking. The principal dimensions of the chimney are:—Total height, 468 feet; from surface to top of cope, 454 feet; outside diameter at foundation, 50 feet; at surface, 34 feet; at cope 14 feet. According to calculations made by Professor Rankine, the building, independent of the adhesion to mortar, is capable of sustaining with safety a lateral pressure of 66 lb. per superficial foot at its weakest point, being 11 lb. more than the force of the greatest storm registered in this country.—*North British Mail.*

THE GOVERNMENT CONE TELEGRAPH SYSTEM.

THE Government have secured to themselves the use of an improved System of Telegraph Signalling, patented by Mr. Redi, of whom they are stated to have obtained it for a very small sum—but for which they would in all probability have rejected it.

Instead of the various and numerous flags hitherto used on board ship for telegraphic signalling, Mr. Redi employs simply a set of collapsible cones, which may be expanded separately or together, as desired. They are formed in pairs, base to base; they are closed by india-rubber springs, and expanded by the pulling of a line or cord. The *notation* of the old flag system only is done away with; the *code* remains unaltered.

This new system has many advantages. Thus, a flag cannot be seen unless "spread" by the wind, and in wet still weather it is often difficult to spread it; but the cones are expanded with certainty in an instant. Again, when a flag is spread, the colour has to be detected; but the colour of the cones has nothing to do with their signalling, nor is their re-acting much affected by the atmosphere; and communication has even been kept up with the cones during an easterly mirage. The cone system can also be worked with greater rapidity than the flags; yet, while the new system admits of more numerous combinations than the old, it is also learnt with greater ease. In respect of cost, 25 sets of cones may be purchased at the price of one set of flags. If we compare the cone telegraph with the semaphore used for naval and military purposes on shore, we shall also find the new system has the advantage. It may therefore be used both by land and sea with benefit, and with the further advantage of rendering the telegraph system common to the army and navy, and of thus facilitating the co-operation of the two services. Yet this self-evident superior system was not adopted by the Admiralty until after some years of hesitation!—*Condensed from the Mechanics' Magazine.*

THE LIVERPOOL AND MANCHESTER RAILWAY.

MR. GEORGE RENNIE has communicated to the Editor of the *Engineer* of November 12, 1859, the following details, of special importance in the history of the railway system:—

In your leading article of the 28th ultimo, you state, "That professional authority, for which many have sought to found a claim of infallibility, has on numberless occasions been completely set at nought, to the great advantage of the civilized world. No higher authority than Mr. Rennie could have pronounced against the practicability of working the Liverpool and Manchester Railway, yet it nevertheless was successful." Now, the answer to this is, that there is no truth whatever in the statement; for I neither did, in my evidence in the Committees of Lords or Commons, or elsewhere, give any one reason to suppose that I had made such a statement. It would have been contrary to my conviction, after the numerous investigations I had made upon the working of the railways then existing in the northern and western parts of the kingdom, such as the Stockton and Darlington Railway, and which was one of the first examples of the successful application of locomotive power on a railway for passengers. Irrespective of this, I had made in 1825, 1826, a vast number of experiments on the gliding and rolling friction of metals and other substances, part of which experiments were communicated to and published in the *Transactions of the*

Royal Society in 1828, three years previously to the experiments of M. Morin, and they have (I believe) formed the basis of all subsequent calculations on that subject. I also made numerous experiments on the gliding and rolling frictions of locomotive engines and carriages, with a view to their application to railways, so that their resistances might be reduced to a minimum, and be equalized with the resistances of barges on canals, and much superior in point of speed. These facts arrived at, it became a question for consideration as to the best line for adoption, and in what way the railway should be laid. An attentive and personal examination of the country intervening between Liverpool and Manchester led to the conclusion that the straightest, and shortest, and most level line was the best, and having through the energy and activity of Mr. Charles Vignoles (employed by us) completed the survey, we decided to adopt the present as the best suited to the contour of the country, and carrying out the great object contemplated. The physical difficulties were, however, great. The construction of the tunnel at Liverpool, on so great a scale, through the red sandstone rock; the crossing of the great Sankey Valley and its canal by a long and lofty viaduct or bridge and embankment; also the Newton Valley and bridge and embankment, besides other valleys of great length and depth; the construction of upwards of 100 bridges over and under the railway, the proportions necessary to give to those bridges; the deep cutting through Olive Mount and Rainhill; the graduation of the line by suitable inclined planes; the carrying the roadway over the much-dreaded Chat and Parr Mosses; the determination of the width of gauge and distance between the lines of railway, &c. &c., all of which subjects were scarcely known, involved difficulties of no ordinary kind, nevertheless we deemed them practicable, and laid out the line as per a brief statement accompanying Mr. Rennie's letter.

In conclusion, Mr. Rennie says:—The original estimate for executing the railway, and submitted to the committee, was 796,246*l*. This sum appeared so large that the estimate was reduced by the committee to 510,000*l*. The railway was executed and opened for commerce in 1830 for 739,165*l*.; and a comparison of other items with those executed will show that we were not so far out as was predicted. But the points to which I would draw your attention are—Firstly, the tunnel, which was entirely new on such a scale of magnitude; secondly, the *inclinations* or *gradients*, which were laid out with the view to the adoption of steam or locomotive power; thirdly, the *width of the gauge* of 5 feet for the distance between the rails, instead of 4 feet 8½ inches—the gauge since adopted for most of the railways throughout the kingdom and elsewhere. Had our gauge been adopted, in all probability we should not have had the wide gauge. And, fourthly, the carrying the railway over Chat Moss. When we surveyed it, we found a good road over the middle of it capable of bearing a horse and cart, and other parts of the Moss cultivated by the justly celebrated Mr. Roscoe; also by a Mr. Borron, of Wolden Hall, on the west side of the Moss; a gentleman who had studied and successfully cultivated a considerable portion of the Moss, and from whom we derived much valuable information; so that, guided by former experience in draining extensive marshes, we felt no apprehensions about Chat Moss; and the results of this experience we communicated to the directors in our report on the best mode of carrying the line of railway over Chat Moss; so that, with all this knowledge before us, it was not likely that we should stultify ourselves and *our employers* by pronouncing the working of the Liverpool and Manchester Railway impracticable.

The article in the *Engineer* referred to by Mr. Rennie, was written under a misapprehension, which, as respecting himself, the Editor admits to be entirely removed.

GREAT SPANS IN RAILWAY BRIDGES.

THE widest single span of any railway bridge in the world is that of the Niagara Suspension Bridge connecting the American and Canadian railways at Niagara Falls. The clear span is 822 feet. A still wider single span—one of 1224 feet—is being constructed for carrying the Lexington and Danville Railway, at an elevation of 300 feet, over the Kentucky river, in the United States. The next widest spans are those of the Britannia Bridge, 460 feet each. Then come the two great spans of the Saltash Bridge, of 455 feet each. The next great railway span is that of the Conway Bridge, of 400 feet. The next is the immense bridge carrying the Royal Eastern Prussian Railway over the Vistula, at Dirschau. This is an iron lattice bridge, having six spans of 397 feet 3 inches each. The Nogat Bridge, on the same line, has two iron lattice spans of 321 feet, and one span of 53 feet 6 inches. The great railway bridge recently opened at Cologne has four lattice spans of 344 feet 6 inches each. The openings of the railway bridge at Kehl will be nearly as wide. The middle opening of the Great Victoria Bridge at Montreal is 330 feet wide, the other twenty-four openings being each 242 feet. The Chepstow Bridge has a span of 300 feet, besides three side spans of 100 feet each. The Boyne Viaduct has one lattice span of a clear width of 264 feet, and two side spans of 138 feet 8 inches each. The Newark Dyke Bridge, the largest example of Warren's trussed girders, has a span of 240 feet 6 inches. Several of the tubular bridges erected by E. Gouin and Co., of Paris, over the Garonne, the Lot, the Tarn, &c., have spans of 80 mètres, or 262 feet. The Spey Viaduct, on the Inverness and Aberdeen Junction Railway, consists of a pair of box girders of a clear span of 230 feet. The tubular bridge at Brotherton has a span of 225 feet. The greatest timber span in a railway bridge, and now indeed the widest timber span in existence, is one of 275 feet, that of the Gascade Bridge, on the New York and Erie Railway, in the United States. The Market-street (highway) Bridge, formerly crossing the Schuylkill, at Philadelphia, U.S., had a timber span of 340 feet; whilst a timber span of 390 feet, the widest ever attempted in that material, was constructed by John Grubenmann over the Limmat, in Germany, in 1794, and was burnt shortly afterwards by the French troops. Railway bridges, with timber spans of 250 feet, are not uncommon in the United States. The great railway bridge across the Mississippi River at Rock Island has five timber spans of 250 feet each, besides three others of 150 feet. The bridge by which the Ohio and Mississippi Railway crosses the Great Miami River, has five timber spans of 250 feet each; and another railway bridge, having two timber spans of 260 feet each, crosses the Delaware River, near Port Jervis, State of New York. The widest masonry span ever erected for railway purposes is one of 180 feet, carrying the Glasgow and South-Western Railway over the river Ayr. The new railway bridge being carried across the Thames at Pimlico will have four cast-iron arches of 175 feet each, the widest cast-iron spans, we believe, yet employed for railway purposes. The six spans of the celebrated High-level Bridge at Newcastle are but 125 feet each in width.—*The Engineer.*

THE ROYAL ALBERT BRIDGE, SALTASH.

The Albert Bridge, which has been formally opened by the Prince Consort, is on the Cornwall Railway, and must be placed amongst the most remarkable achievements of engineering skill. It consists of nineteen spans. Seventeen of these spans are wider than the widest arches of Westminster Bridge, while two, resting on a cast-iron pier of four columns, cross the whole stream of the Tamar, at a leap of upwards of 900 feet, or a greater distance than the breadth of the Thames at Westminster. The total length of the structure from end to end is 2240 feet. Its greatest width, as formed only for a single pair of rails, is 30 feet at basement, its height from foundation to summit no less than 260 feet, or more than 50 feet higher than the Monument.

Mr. Brunel was, unfortunately, not able to be present; Mr. Brereton, the resident engineer, supplied his place. The *Times* gives a very full account of the structure, and from that we take the following particulars :—

> The seventeen smaller spans consist of massive double columns of solid masonry, 11 feet square, with wrought-iron longitudinal beams of boiler-plate, to carry the roadway on either side. The main stone piers are at the water's edge, and support the ends of the great spans crossing the river. These two, of course, are of the most solid kind. Each is of granite, 29 feet wide by 17 feet thick, and no less than 190 feet from foundation to summit. It is, however, on the main pier, in the centre of the river, on which both the great spans rest, that all the pressure and vibration comes, and for this was required a tower of such proportions that nothing short of the solid rock itself would suffice for its foundation. But to reach this was a matter of no ordinary difficulty, inasmuch as some 70 feet of sea water, with 20 feet of mud and concrete gravel, lay between Mr. Brunel and the stone on which he wished to build. A cofferdam for such a depth, and in such a tideway, was out of the question; yet, by a most ingenious application of the cofferdam principle, what seemed an insuperable obstacle was at last overcome. An immense wrought-iron cylinder of boiler-plate, 100 feet high and 37 feet in diameter, and weighing upwards of 300 tons, was made and sunk exactly on the spot whence the masonry was to rise. From this the water was pumped out and air forced in; the men descended, and working as in a gigantic diving-bell at the bottom of the river, cleared out the mud and gravel until the rock was reached and hewn into form to support the cylinder evenly all round. Powerful steam air-pumps were necessary to keep the labourers supplied below, and, as a matter of course, they worked at an atmospheric pressure of upwards of 35 lb. to the inch. On this massive pile, built in the cylinder, the iron columns for the centre pier are raised. Until these ponderous masses were cast, metal works of such dimensions were seldom dreamt of. There are four octagon columns, 10 feet in diameter and 100 feet high. Each stands 10 feet apart from the other in the centre of the granite, forming a square of about 30 feet, and all bound together with a massive lattice-work of wrought-iron, which checks vibration, and prevents any lateral thrust. The weight of each column is 150 tons, each being cast in 6-feet joints, 2 inches thick, and supported inside with powerful ribs and angle irons. The great spans, each end of which rests on two of these columns, may be best described as being made on the principle of a double bow. The lower bow is of chains, carrying the roadway; the upper is a tube of wrought-iron, to which the lower is attached by powerful supports. Thus a great weight on the lower bow only tends to give additional support by straightening the upper, and *vice versâ*: each, in fact, counteracts the effect of the other, so that there is no lateral thrust from either side, an indispensable requisite where no buttresses could be erected to resist it. Each arched tube is elliptical in form, being 12 feet by 17 feet, and both are made throughout of inch boiler-plate. At intervals of 20 feet the insides are wrought-iron diaphragms, with tie-rods and angle-irons throughout their entire length. The curve of the arched tube is 28 feet, and the tension chains of the lower bow are of course the same. The double chains are exactly similar in principle to those of an ordinary suspension-bridge, only, instead of each link being composed of seven and eight bars, those at Saltash are of fourteen and fifteen bars, each bar being 1 inch thick and 6 inches broad, and each link having been tested with a strain of four tons to the inch. Both the chains and tubes are bound together by wrought-

iron trusses to each other. The spans before being lifted were tested with a strain (including their own weight) of 2300 tons. When the whole bridge takes its bearing, the pressure on the centre pier foundation will be more than eight tons to the foot. The total quantity of wrought iron used has been 2700 tons; of cast iron, 1300 tons; of masonry and brickwork, 17,000 cubic yards; and about 14,000 cubic feet of timber.

RAILWAY BREAKS.

Mr. W. Fairbairn has read to the British Association a paper "On Experiments to determine the efficacy of continuous and self-acting Breaks for Railway Trains." Of late years, Mr. Fairbairn remarked, the improvements introduced to diminish the danger of railway travelling have been specially directed to increasing the retarding power of various kinds of breaks. The importance has been felt of reducing the momentum of trains with ease and rapidity, that is, in the least time and in the shortest distance. On this subject, a most important communication had been made to the Railway Department of the Board of Trade by Col. Yolland, who had experimented with breaks which were improvements on the ordinary breaks. The breaks used were the steam break of M'Connell, the continuous break of Fay, the self-acting break of Newall, and the self-acting buffer break of Guerin. Col. Yolland had reported in favour of Newall's break for heavy traffic, and also in favour of that of Guerin under certain circumstances. Similar experiments had been carried out by Mr. Fairbairn on the Lancashire and Yorkshire Railways. The breaks he used were those of Fay and Newall, and consisted of break blocks, acting on every wheel of the carriages of the whole train—the break blocks being suspended on flaps or placed on side-bars under the carriages. Powerful springs had also been applied under each carriage, by means of which the breaks were made to act instantaneously throughout the whole train by the act of one guard only, and this was one of the most important features of these breaks. The trains passed over a measured distance by the action of gravity. The trains employed consisted of three weighted carriages each. They were started by removing a stop. Having descended a previously measured distance with a uniformly accelerating velocity, they passed over a detonating signal, which gave notice to the guard to put on the break. On making experiments at Southport, a retarding force per ton weight was gained of 382·6 lb. for Newall's break, and 406·4 lb. for Fay's. The general result of the whole experiment showed that a train could be stopped by these breaks at a velocity of 20 miles an hour in 23·4 yards; 40 miles an hour in 93·8 yards; 50 miles an hour in 146·8, and 60 miles an hour in 211·5 yards. This clearly showed the advantage of these breaks in power.

RELATIVE VALUE OF COAL AND COKE IN LOCOMOTIVE ENGINES.

Mr. B. Fothergill has submitted to the Society of Arts the results of a series of experiments which he has made with Coal and Coke in Locomotive Engines, and which have led him to the conclu- that coal is decidedly superior to coke in respect to heating power, and consequently more economical; that a plentiful supply of steam can be generated by it for working engines at high velocities, and for drawing heavy trains; that coal-burning engines can be made to consume their own smoke, and that the fire-boxes and tubes when coal was used were found to last longer. His contrivance consists in so dividing the fire-box as to increase the amount of direct heating surface and to diminish the indirect or tube surface, whilst the combustion chamber affords sufficient space for the introduction of a series of fire tiles, for the purpose of retaining a portion of the heat given off from the combustion of the gases, and for diffusing the unconsumed carbon, as well as effecting a complete mixture of the air with the gases, and thereby producing a mass of flames which is brought in contact with the direct heating surface of the combustion chamber before it enters the tubes, at the same time preventing practically such an escape of smoke from the chimney as could be deemed a nuisance. In addition to the practical experiments made by the author on the South-Western Railway, a series of accurate analyses with the view of ascertaining the composition and heating power of various kinds of coke and coal has been made, and from all these investigations it appears that a saving of from 8½ to about 10¾ lbs. of coke per mile, which, of course, represents a larger quantity of coal, is effected by the use of coal in the patent fire-box described, as compared with the quantity of coke consumed in the ordinary engines under similar circumstances. With regard to the durability of the tubes, it has been found that in the coke-burning engines, about 94,000 miles are the average duration of a set of tubes, whilst of the experimental engines burning coal, one had already run 181,000 miles, and the tubes were still in good condition. The author, therefore, expressed a strong opinion in favour of the advantages of coal over coke for locomotive engines.

COAL-BURNING LOCOMOTIVES WITHOUT SMOKE.

A PAPER has been read to the British Association, by Mr. D. Kinnear Clarke, on his "System of Coal-burning without smoke, by the method of steam inducted air-currents, applied to the locomotive engines of the Great North of Scotland Railway."

The substitution of coal, as fuel, for coke in locomotives, is not only felt to be a commercial necessity for the reduction of expenditure, but is also discovered to be perfectly practicable as a mechanical problem in conformity with the conditions laid down by the railway Acts of Parliament, that railway engines shall consume their own smoke. The means of doing so, to be adaptable to a locomotive engine, must be simple in design, facile of application to existing locomotive stock, easy to manage, easy to maintain, efficient in promoting the combustion of coal without smoke, keeping up the steam, and saving expense.

These desirable qualifications the writer believes belong to this system of smoke prevention. The whole apparatus is external to the fire-box, and therefore not exposed to heat; and it is controlled in the most perfect manner by a single stop-cock. Air is admitted above the fuel by one or more rows of tubes inserted through the walls of the fire-box, and jets of steam are projected through the air-tubes from nozzles $\frac{1}{16}$th inch diameter, in small steam-pipes, placed outside the fire-box, to increase the quantity and force of the air admitted above the fuel in order to consume the smoke. The jets of steam are used principally when the engine is standing, with the aid of a light draught from a ring-jet in the chimney, to carry off the products of combustion, and they may be shut off when not required. The supply of air through the tube may also be regulated by dampers.

The grate-bars are placed close together, with narrow air-spaces, and the ash-pan and damper are lightly fitted. The level of the fuel should at all times be below the air-tubes.

This system is working with entire success on the engines of the Great North of Scotland Railway, at Aberdeen. It is also successfully at work daily (amongst other lines) on several of the engines of the North London Railway, where, as a metropolitan line, the regulations against smoke nuisance are rigidly enforced. It requires a less weight of coal than the engines formerly required of coke for the same duty; and thus saves more than the whole difference in the price of the two fuels.

The locomotive engine has been variously cut up and mangled in order to suit the views of designers for the combustion of coal without smoke. In the plan before the meeting, the original type of engine promulgated by Mr. Stephenson, and at this day universally adopted and unsurpassed, is preserved intact; and the locomotive is thus rendered a complete and perfect machine, and entirely meets the great railway necessity of the day—the perfect combustion of coal in railway engines.

TURNPIKE LOCOMOTIVE.

A STEAM-ENGINE has been constructed for the Marquis of Stafford, at Buckingham, for travelling on the turnpike-road. In front there is a seat for four persons, and the engine is guided by a handle in front. It weighs about 22 cwt., is of two-horse power, and will travel at the rate of fourteen miles an hour. It runs upon three wheels, and is guided by a handle in front similar to a velocipede. It is fitted with a seat in front, capable of holding four passengers, including the driver.

NEW SYSTEM OF AXLE-BOXES.

A PAPER has been read to the Institution of Civil Engineers, "On a New System of Axle-boxes not requiring Lubricating, and without liability to Heating," by M. Alphonse de Brussaut. The author describes this system, which he has applied somewhat extensively, in France, to various classes of machinery in which the use of grease has hitherto been considered indispensable. The new apparatus consists of a series of four, six, eight, or any other convenient number of cylindrical rollers, of the length of the journal, etained at certain distances apart from each other, yet still united by elastic bands of vulcanized india-rubber. These rollers, thus united, and placed around the journal, are set in motion by the pressure of the axle, without the possibility of collision with, or friction against each other, or of rubbing upon the surface of the journal, or of the bearing, and thus avoiding, as much as possible, any friction, or opposition to the motion of the journal. The action of rolling being thus substituted for sliding, there cannot be any abrasion of the substances, and lubricating becomes unnecessary. The machines, so fitted, are stated to work with remarkable ease and steadiness, and to be set in motion, and the speed to be kept up, with considerable facility. No inconvenience has been experienced from the fracture of the elastic bands, and shafts making 450 to 500 revolutions per minute, work perfectly well, without any symptom of heating.

The reasons for this action were stated in a plain and comprehensive manner, by showing that in moving a body of an octagonal form along a plane, the action must be either by sliding, or by rolling; in the former, lubrication is necessary, whereas in the latter, the presence of any lubricating matter would be prejudicial. Extending the latter principle to the cylindrical form, which is merely a body having an indefinite number of sides, it is evident that, by retaining these cylinders apart, by means of the elastic bands, so as to avoid friction against each other, or upon the journal or the bearing surface, a practically perfect rolling motion will be obtained, and it was contended that by M. Brussaut's system, the two material results of rapid rotation without heating, and a complete suppression of the use of grease in all journals of machinery, were arrived at.

SAFETY CAGE FOR MINERS.

Mr. Robert Aytoun has described to the British Association his invention of this Cage, the object of which is to save the lives of Miners who may happen to be in the cage at a time when the rope to which it is attached gives way.

It fortunately happens that almost every shaft is provided with a pair of strong wooden rods, called guide-rods, which extend from top to bottom. These are placed on opposite sides of the shaft with the cage between them. The latter is furnished with iron shoes or slides at top and bottom, which loosely embrace the guide-rods and constrain it to keep one path in ascending and descending.

To cause the cage, on the failure of the winding tackle, to cling to these guide-rods, is the object sought in all safety cages.

My plan for effecting this is a mere adaptation of an instrument well known to miners—the key or wrench used for raising and lowering the boring-rods. This little instrument has never been known to lose its hold. It supports 100 fathoms of rods with the same tenacity that it does ten. Indeed, the greater the weight it is required to hold, the firmer is the gripe. It therefore is admirably calculated to support the cage, which, in addition to its own weight and load, may have to bear the weight of some hundred fathoms of rope precipitated on it from above.

To adapt this instrument to the cage, a slight modification of the upper shoes and slides is all that is necessary. These shoes or slides are, as usual, two in number, and placed on the opposite sides of the cage and in opposite directions. Each of them has a single bolt or stud, by which it is attached to the cage, and around which it turns; a long arm, to the extremity of which the winding chain is attached; a stop, which prevents the arm from being pulled above the horizontal line; and a spring, which lowers it when the winding chain is slack.

From this description it is easily seen that in the event of the rope or gearing giving way, the springs so tilt the shoes or slides that they immediately seize hold of the guide-rods, in the same manner as the boring key in the hands of a miner lays hold of the boring rods, and with the same tenacity of gripe; and although the rope should come down on the top of the cage, the only effect woul be to cause the shoes to dig deeper into the guide-rods, and thus to make the hold more secure.

IMPROVED MANUFACTURE OF STEEL.

In the *Year-Book of Facts*, 1859, pp. 82, 83, we described, from the *Mechanics' Magazine*, the production of Steel at prices very much below those of the English and American Markets, by the Damascus Steel and Iron Company. All the statements then made have been fully corroborated by the intelligence subsequently received of this great American invention; and the course of experiments since made has led to still more extraordinary results. The following details are from the *Mechanics' Magazine* of the past year:—

The impurities with which Mr. Bessemer, as he has lately informed us, has experienced the greatest difficulty, and those which so long retarded the progress of his remarkable invention, were sulphur and phosphorus; and, curiously enough, sulphur and phosphorus are precisely those impurities which Mr. Farrar, the inventor of this much more remarkable process, has more especially aimed at removing throughout his proceedings—with how much success we have already implied. Among the specialities of the new process are, first, economy of time in the manufacture by direct conversion of the iron in the crucible in three hours, doing away entirely with the tedious process of cementation, which takes from ten to twenty days. Secondly, from the same irons as are used under the old method, the inventor produces a superior steel of a more uniform character, possessing more tenacity and ductility; and from any given quantity of iron the *same quantity* of any required grade of steel, there being no loss in the melting. Thirdly, he purifies iron from all foreign substances by means of chemicals, and thus makes available for good cast-steel a lower grade of iron than can be used in any known method. Fourthly, the cost of producing any kind of steel will be simply the cost of the bar-iron used, added to which must be the same expense as is now attendant upon producing it from "blister-steel," *i.e.*, melting, hammering, rolling, &c. Fifthly, the process has also the great advantage of enabling parties to make malleable castings from ordinary wrought-iron, or wrought-iron scrap, a mode of manufacture which is peculiarly adapted for railway carriage wheels, and other castings requiring great strength, both tensile and other. This material is also adapted for gas and water-pipe couplings, for which annealed cast-iron castings are now used, and possesses infinitely more strength; it is likewise suitable for light ordnance and any castings under 30 cwt. The patentee does not claim to make the best steel out of poor irons. The two great enemies of iron are, as we have intimated, sulphur and phosphorus, which, from the chemicals used, pass off in a nascent state.

The Damascus Steel and Iron Company of New York are now making from three to six tons of best cast-steel per day out of American iron by this process, producing finished bar-steel at a cost not over 28*l.* a ton of a quality equal to that made here out of the best brands, costing in iron bar 30*l.* to 36*l.* a ton. From an iron puddled by the Damascus Company direct from the ore, and by Anthracite coal, they are producing a steel sufficiently good for the best machinery steel, and saws, &c. The iron costs not more than 8*l.* a ton, and, when manufactured by this process, not more than 20*l.* a ton.

It is said that good steel cannot be made of common iron; nor can that be done, unless the iron is first purified of foreign substances, and thereby brought up to a better grade of iron, and better adapted for steel purposes. There are some irons in which it is impossible to reach all the impurities, viz., those containing much arsenic; with these the method would fail; but it is a fact, that for all second and third class steels there is plenty of English iron, and the second and third grades of Swedish iron are good enough for the very best steel.

EXPERIMENTS AS TO THE STRENGTH OF WIRE ROPE.

SOME Experiments have been made at the Corporation Testing Works, King's Dock, on Wire Rope manufactured by Messrs. Garnock, Bibby, and Co., for the purpose of proving the strength of steel wire in comparison with the ordinary wire rope: they were conducted under the superintendence of Mr. Macdonald, superintendent of the testing machine, and witnessed by Captain Cornforth and others. The first piece put to the test was a length of 3 fathoms charcoal wire rope, 3 inches in circumference, which broke at 13 tons—a tension of 1 ton 6 cwt. above the manufacturers' tables. The next was a length of 3 fathoms of 3 inches ordinary puddled steel wire rope, which gave way at a strain of 13 tons 15 cwt.; and the last was a similar length of steel wire, but differently prepared, which stood a strain of 16 tons 5 cwt.

BESSEMER'S IMPROVED MANUFACTURE OF MALLEABLE IRON AND STEEL.

MR. BESSEMER has read to the Institution of Civil Engineers a paper in which he details the progress he has made in his new process since 1856, when it was first brought before the British Association.*

Chemical investigation has pointed out to the inventor the real source of difficulty, by showing that, although the metal could be wholly decarbonised, and the silic can be removed, the quantity of sulphur and phosphorus was but little affected; and analysis showed that red shortness was always produced by sulphur, when present to the extent of $\frac{1}{10}$th per cent., and that cold shortness resulted from the presence of a like quantity of sulphur. Steam and pure hydrogen-gas were tried in the removal of the sulphur; and various fluxes, composed chiefly of silicates of the oxide of iron and manganese, were brought in contact with the fluid metal during the process, and the quantity of phosphorus was thereby reduced. Thus many months were consumed in laborious and expensive experiments, from which many valuable facts were elicited. The successful working of some of the higher qualities of pig iron caused a total change in the process, to which the efforts of Messrs. Bessemer and Longsdon were directed. It was determined to import some of the best Swedish pig-iron, from which steel of excellent quality was made. It was decided to erect steel works at Sheffield, for the express purpose of fully developing and working the new process commercially, and thus to remove the erroneous impressions so generally entertained in reference to the Bessemer process.

In manufacturing tool steel of the highest quality, it was found preferable, for several reasons, to use the best Swedish pig-iron, and, when converted into steel by the Bessemer process, to pour the fluid steel into water, and afterwards to re-melt the shotted metal in a crucible, as at present practised in making blister-steel, whereby the small ingots required for this particular article were more perfectly and more readily made.

There exist in this country vast, and apparently inexhaustible, beds of the purest ores, fitted for the process. Of the Hematite alone, 970,000 tons are raised annually, and this quantity might be doubled or trebled, whenever a demand arose. It was from the Hematite pig-iron, made at the Workington Iron Works, that most of the larger samples of iron and steel exhibited were made. About 1 ton 13 cwt. of ore, costing 10*s*. per ton, would yield 1 ton of pig metal, with 60 per cent. less lime, and 20 per cent. less fuel, than were generally consumed when working inferior ores; while the furnaces using this ore alone yielded from 220 to 240 tons per week, instead of say 160 to 180 tons per week, when working with common ironstone. The Cleator Moor, the Weardale, and the Forest of Dean Iron Works, also produced an excellent metal for this purpose.

The form of converting vessel which had been found most suitable somewhat resembled the glass retort used by chemists for distillation. It was mounted on axes, and was lined with "Ganister" or road drift, which lasted during the conversion of thirty or forty charges of steel, and was then quickly and cheaply repaired or renewed. The vessel was brought into an inclined position to receive the charge of crude iron, during which time the tuyeres were above the surface of the metal. As soon as the whole charge was run in, the vessel was moved on its axes, so as to bring the tuyeres below the level of the metal, when the process was at once brought into full activity, and twenty small, though powerful, jets of air sprung upwards through the fluid mass; the air, expanding in volume, divided itself into globules, or burst violently upwards, carrying with it a large quantity of the fluid metal, which again fell back into the boiling mass below. The oxygen of the air appeared, in this process, first to produce the combustion of the carbon contained in the iron, and at the same time to oxydize the silicum, producing silicic acid, which, uniting with the oxide of iron obtained by the combustion of a small quantity of metallic iron, thus produced a fluid silicate of the oxide of iron, or "cinder," which was retained in the vessel and assisted in purifying the metal. The increase of temperature which the metal underwent, and which seemed so disproportionate to the quantity of carbon and iron consumed, was doubtless owing to the favourable circumstances under which combustion took place. There was no intercepting material to absorb the heat generated and to prevent its being taken up by the metal, for heat was evolved at thousands of points, distributed throughout the fluid, and when the metal boiled, the whole mass rose far above its natural level, forming a sort of spongy froth, with an intensely vivid combustion going on in every one of its numberless ever-changing cavities. Thus by the mere action of the blast, a temperature was attained, in the largest masses of metal, in ten or twelve minutes, that whole days of exposure in the most powerful furnace would fail to produce.

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* See *Year-Book of Facts*, 1857, pp. 5—10.

The amount of decarbonization of the metal was regulated, with great accuracy, by a meter, which indicated on a dial the number of cubic feet of air that had passed through the metal; so that steel of any quality or temper could be obtained with the greatest certainty. As soon as the metal had reached the desired point (as indicated by the dial), the workmen moved the vessel, so as to pour out the fluid malleable iron, or steel, into a founder's ladle, which was attached to the arm of a hydraulic crane, so as to be brought readily over the moulds. The ladle was provided with a fire-clay plug at the bottom, the raising of which, by a lever, allowed the fluid metal to descend in a clear vertical stream into the moulds, which were thus successively filled.

The casting of large masses of a perfectly homogeneous malleable metal, into any desired form, rendered unnecessary the tedious, expensive, and uncertain operation of welding, now employed. The extreme toughness and extensibility of the Bessemer iron was proved by the bending of cold bars of iron 3 inches square, under the hammer, into a close fold, without the smallest perceptible rupture of the metal at any part. An iron cable, consisting of four strands of round-iron 1¼ inch diameter, was so closely twisted, while cold, as to cause the strands, at the point of contact, to be permanently imbedded into each other. The steel and iron boiler-plates, left without shearing, and with their ends bent over cold, also afforded ample evidence of the extreme tenacity and toughness of the metal; while the clear, even surface of the railway axle and piece of malleable iron ordnance, were examples of the perfect freedom from cracks and flaws, or hard.

The reduction in the cost of plates for boilers and for shipbuilding, by the new process, was so great as to be less troublesome, less expensive, and less wasteful of the material, to make plates weighing from 10 to 20 cwt., than to produce smaller ones by the old process.

By the Bessemer process, also, masses of malleable iron and steel may be formed for the heaviest ordnance, without any welding together of separate slabs, or the more costly mode of building up the gun with pieces accurately turned and fitted together. Wrought-iron ordnance has been produced, as in the Mersey gun, but the time required to make it, and its immense cost, manifestly rendered it still a great desideratum to produce guns rapidly and cheaply, of a material equal to, or greater in tensile strength, than wrought-iron, and, if possible, free from the liability which that material had, to flaws and to deterioration, during its long exposure to a welding heat. It was believed that the Bessemer process supplied this desideratum; as masses of cast malleable metal could be produced of 10 or 20 tons in weight in a single piece, and two or three such pieces might be conveniently made, by the same apparatus, in one day. The metal so made might be either soft malleable iron or soft steel. In order to prove the extreme toughness of such iron, and the strain to which it might be subjected, without bursting, several cast and hammered cylinders were placed cold under the steam hammer, and were crushed down, without the least tearing of the metal, as was shown by the samples exhibited. Three cylinders were drawn from a round cast-iron ingot of only 2 inches greater diameter than the finished cylinder, and in the precise way in which a gun would be treated; they might, therefore, be considered as short sections of an ordinary 9-pounder field-piece. The tensile strength of the samples, as tested at the Royal Arsenal, was 64,566 lbs. per square inch, while the tensile strength of pieces cut from the Mersey gun, gave a mean of 50,624 lbs. longitudinally, and 43,339 lbs. across the grain; thus showing a mean of 17,550 lbs. per square inch in favour of the Bessemer iron.

Conical masses of this pure tough metal, of from 5 to 10 tons in weight, could be procured at Woolwich at 6*l.* 12*s.* per ton, inclusive of the cost of fining-iron, carriage, re-melting, waste in the process, labour, and engine power.

If it was desired to produce ordnance by merely casting the metal, the ordinary founding process might be employed, with the simple difference that the iron, instead of running direct from the melting furnace into the mould, must first be run into the converting vessel, where in ten minutes it would become steel, or malleable iron, as was desired, and the casting might then take place in the ordinary manner. Mr. Bessemer exhibited in proof, a small piece of ordnance, being the first gun that was ever made in malleable iron without a weld or joint.

The new process is rapidly extending itself over Europe. The firm of Daniel Elfstrand and Co., of Edsken, in Sweden, has made several hundred tons of excellent steel by the Bessemer process. Four other establishments are making arrangements to use the process, and the authorities in Sweden have pronounced in favour of the process. A large steel circular saw plate, exhibited by Mr. Bessemer, was made by Mr. Göranson, of Geffle, in Sweden, the ingot being cast direct from the fluid metal, within fifteen minutes of its leaving the blast furnace.*

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* See a notice of the progress of the Bessemer process on the Continent, in the *Year-Book of Facts*, 1859, pp. 83, 84.

That the process admitted of further improvement, and of a vast extension beyond its present limits, the author had no doubt; but those steps in advance would, he imagined, result chiefly from the experience gained in the daily commercial working of the process. Hitherto it had been brought into its present practical and commercial state, without recourse to any of the numerous inventions which were supposed by the several authors to be essential to the success of the system; but any real improvement that might be brought forward, would be cordially received and encouraged.

THE STRENGTH OF WROUGHT-IRON AND STEEL.

THE following condensed abstract of a first set of experiments, made by Messrs. Robert Napier and Sons, on the strength of Wrought-Iron and Steel, was communicated to the British Association at the Aberdeen meeting by Professor W. J. Macquorn Rankine, C.E., LL.D., &c. The experiments to which this abstract relates form the first set of a long series now in progress by Messrs. Robert Napier and Sons, the details being conducted by their assistant, Mr. Kirkaldy. The whole results are now in the course of being printed *in extenso*, for publication in the *Transactions of the Institution of Engineers in Scotland*.

The present abstract is all that it has been found practicable to prepare in time for the meeting of the British Association, and, notwithstanding its brevity and extreme condensation, it is believed that the results which it shows will be found of interest and importance. It gives the tenacity, and the ultimate extension, when on the point of being torn asunder, of the *strongest* and the *weakest* kinds of iron and steel from each of the districts mentioned. Each result is the mean of four experiments at least, and sometimes of many more.

The detailed tables will show many more particulars, and especially the contraction of the bars in transverse area along their length generally, owing to "drawing out," and the still greater contraction at the point of fracture. The experiments now complete were all made with loads applied gradually. Experiments on the effect of suddenly applied loads are in progress.

TABLE A.—IRON BARS.

	Tenacity in lbs. per sq. inch.	Ultimate extension in decimals of length.
Yorkshire: strongest	62886	0·256
,, weakest	60075	0·205
,, (forged)	66392	0·202
Staffordshire: strongest	62231	0·222
,, weakest	56715	0·225
West of Scotland: strongest	64795	0·173
,, ,, weakest	56655	0·191
Sweden: strongest	48232	0·264
,, weakest	47855	0·278
Russia: strongest	56805	0·153
,, weakest	49564	0·133

TABLE B.—IRON PLATES.

	Tenacity in lbs. per sq. inch.	Ultimate extension in decimals of length.
Yorkshire: strongest lengthwise	56005	0·141
„ weakest lengthwise	52000	0·131
„ strongest crosswise	50515	0·093
„ weakest crosswise	46221	0·076

NOTE.—The strongest lengthwise is the weakest crosswise, and *vice versâ*.

TABLE C.—STEEL BARS.

Steel for tools, rivets, &c.: strongest	132909	0·054
„ „ weakest	101151	0·108
Steel for other purposes: strongest	92015	0·153
„ „ weakest	71486	

TABLE D.—STEEL PLATES.

Strongest lengthwise	94289	0·0571
Weakest lengthwise	95594	0·1986
Strongest crosswise	96308	0·0964
Weakest crosswise	69016	0·1964

NOTE.—The strongest and weakest lengthwise are also respectively the strongest and weakest crosswise.

CAST-IRON ARCHES.

AT the Institution of Civil Engineers has been read an "Account of Experiments upon Elliptical Cast-iron Arches," by Mr. T. F. Chappe.

These experiments were undertaken at the request of Mr. W. H. Barlow, M. Inst. C.E., for the purpose of ascertaining, practically, the safe load to which elliptical cast-iron arches might be subjected, as well as the most economical distribution of the metal. The intrados of the arches was, in all cases, a segment of an ellipse, in order to obtain the greatest headway at the haunches. The experiments were in each case conducted upon two ribs, placed two feet apart from centre to centre, and resting on cast-iron abutment pieces, keyed up tight against the springings. Diagonal stays and longitudinal struts were also introduced to prevent lateral motion.

The first experiment was made upon a model, one-fourth the real size, of one arch of a bridge intended to be erected over the river Trent, near Newark. The (model) arch had a clear span of 14 feet 6 inches, and a rise of 16 inches; a camber of ¼ of an inch being given in fixing the halves together. The sectional area of the arch at the crown was 2·43 inches—that of the curved rib near the springing two inches—about midway between the springing and the crown, 1·75 inch, and of the spandril, 1·34 inch. The weight of each arch was 1 cwt. 2 qrs. 22 lbs.

The other experiments were made upon a model, one-sixth the real size, of an arch erected over the Gloucester and Stonehouse and Great Western Railways, at Standish, six miles from Gloucester. The dimensions of the model were, span, 13 feet 10¾ in., and rise 1 foot 10 in. The sectional area, at the crown, was 1·25 inch, of the curved rib near the springing, 1·055 inch, about midway between the springing and the crown, 0·993 inch, about the middle of the upper rib, 0·883 inch, and of the spandril, 0·57 inch. The weight of each arch was 3 qrs. 26 lbs.

The following pressures were given as those to which the arches were subjected in these experiments :—

Experiment.	Ultimate Load.		How distributed.	Pressure per square inch of Sectional Area.	
				At Crown.	At Smallest Section.
	Tons.	Cwt.		Tons.	Tons.
No. 1	30	10	Uniformly.	8·52	11·83
,, 2	18	0	Ditto.	6·80	8·58
,, 3	12	0	Partially removed from the haunches.	4·54	5·72
,, 4	5	0	On one haunch.	2·36	2·98
	3	12	At Centre.	2·93	3·70
,, 5	3	14	Ditto.	3·00	3·85

In the first experiment, the ultimate pressure was not reached. In the second and third experiments, one-half arch was out of line laterally, beyond what would be permitted in practice, and was wanting in that assistance which would have been afforded, in the number of ribs required for the width of a bridge, so that the ultimate pressures indicated were below what such arches might be estimated to bear. This was also the case in the two last experiments, in which the castings were faulty, and the tests were such as were not likely to occur in practice. It was thought that cast-iron arches, of the form experimented upon, might safely be considered capable of bearing a pressure of between eight and ten tons per square inch of section. From the position of the fractures, it was believed that the spandrils were too weak in proportion to the size of the arches.

The communication was accompanied by several tables, showing the deflections on the application of the different loads.

LARGE IRON FORGINGS.

Mr. R. Mallet has read to the Institution of Civil Engineers a paper "On the Co-efficients of Elasticity and of Rupture, in Wrought-Iron, in relation to the volume of the metallic mass, its metallurgic treatment, and the axial direction of its constituent Crystals."

Iron was formerly entirely worked under tilt-hammers; the process of rolling was then introduced, and now, in consequence of modern engineering requirements, masses of iron, of considerable magnitude, were produced by faggoting together, under heavy forge hammers, from large numbers either of bars, or slabs grouped together. The masses were not, however, found to possess ultimate strength in proportion to the number of bars of which they were composed ; in fact, it appeared that the strength of the mass became less in some proportion as the bulk became greater. This was admitted as a fact, but no one had hitherto attempted to show experimentally what function of the magnitude was the strength of a given kind of iron, manufactured in a given manner; or how the same forged mass, when very large, differed in strength in different directions with reference to its form; or how the mechanical part of the process of manufacture of the same iron affected its actual strength, either as a rolled bar, or as a forged mass.

Addressing himself to this investigation, the author dealt generally with three points of the inquiry—viz.,

1st deg. What difference did the same large bars of unwrought iron afford to forces of tension and of compression, when prepared by rolling, or by hammering under the steam-hammer?

2nd deg. How much weaker, per unit of section, was the iron of very massive hammer forgings, than the original iron bars of which the mass was composed?

3rd deg. What was the average, or safe measure of strength, per unit of section, of the iron composing such very massive forgings, as compared with the acknowledged mean strength of good British bar iron?

(We have not space for the illustrative details.)

Hence was deduced the conclusion, that practically the iron of very heavy shafts, forged guns, huge cranks, and other similar masses, might be expected to become permanently set and crippled, at a trifle above 7 tons per square inch, and to give way by fracture, at about 15 tons per square inch by tension, and to completely lose form at pressures of from 15 to 18 tons per square inch. Therefore it followed that, allowing a deduction of one-half, as sanctioned by practice, from the elastic limits of tension and of pressure, for the margin of safety, the iron of such forged masses should not be trusted for impulsive strains exceeding about 1¾ ton per square inch of tension, and about 4½ tons per square inch of pressure, or for passive tensile strains of 3½ tons per square inch, or for passive pressure beyond 9 tons per square inch.

The whole of the following evening meeting was devoted to the discussion of the above important investigation.

IMPROVED METALLIC SHIPS.

MR. J. SCOTT RUSSELL, the builder of the *Great Eastern*, has patented a novel kind of Metallic Ship, designed apparently to obviate the fouling to which the bottoms of iron vessels are subject. His invention consists in constructing the framing of the ship of angle and other bars, made of yellow or Muntz's metal; and in plating the framing with sheets of a like metal; and also in plating the frames of ships constructed of angle-iron, or other bars of iron, with sheets of yellow or Muntz's metal. The sheets of such yellow or Muntz's metal are to be fastened to each other and to the framing by rivets of the same metal. The cutwaters also, and the stern and rudder posts, and other parts of the framing of ships and vessels, as well as the rudders, are to be by preference of Muntz's or yellow metal. For these purposes it is believed that the best compound or alloy consists of about 60 parts of the best copper, and 40 parts of the best spelter: but such proportions may be varied, as is well known, within moderate limits. "It is preferred," says Mr.

ll, "to construct the frame of a ship or vessel of the yellow metal, and to combine therewith sheets of like metal; but I have by experiment ascertained that the particular alloy of copper and zinc above mentioned, is so near iron in its electrical character, as not to act largely thereon when the two are placed in contact in sea water, and therefore that in constructing a ship or vessel, a frame of iron may advantageously be plated over with sheets of yellow or Muntz's metal, whilst sheets of copper are wholly unsuited for the purpose." Mr. Russell, in his specification of the invention, further says:—"The frame of a vessel when of yellow or Muntz's metal, I construct of any convenient form, as when iron is employed, and employ a similar section of metal both in form and size The yellow or Muntz's metal is brought to the section required by rolling, just as is the case with iron, and it is worked in a similar manner. The sternposts and other parts, which in iron ships are forged, I prefer when yellow or Muntz's metal is used to cast to form. The plating of yellow or Muntz's metal I make of the same thickness as when iron is used, and it is secured to the frame by rivets of yellow or Muntz's metal, which are worked in a similar manner to iron rivets, but care should be taken not to heat the rivets too highly, and not to keep them heated longer than is necessary. When an iron frame is to be plated with yellow or Muntz's metal, it is to be constructed as if an iron plating were to be employed, and the yellow or Muntz's metal plates should be of a thickness such as is usual for plating ships with iron."

DIVIDING METALS BY ROTATION.

A COMMUNICATION has been made to the Society of Civil Engineers of Paris, relative to a new method of obtaining Metals in a Finely-divided state by means of Rotation—in fact, in a manner similar to that which has been used for the production of small shot. In the present instance the machinery employed consists of a disc of fire-clay mounted on a vertical axis, and made to revolve at the rate of 2000 turns a minute. The metal is allowed to fall in a state of fusion upon this disc, and is thrown off in the form of powder, which is cold before it reaches the ground or receptacle. The powder of lead thus obtained is proposed to be used in the production of masticot, or yellow oxide of lead; for this purpose the powder is damped, and then heated to a moderate degree, when the surface of each atom at once becomes covered with the protoxide, which is removed by washing, and the process repeated. By the addition of acid, white lead may in like manner be produced. An experiment was made with the apparatus upon iron, but that metal retained its heat too long to permit the division to take place during the time the molten metal remained in the air; it was suggested, however, that fine iron might be produced for special purposes by submitting it to the action of the machine, in order to disengage from it sulphur, phosphorus, and other foreign matters before moulding. The President of the Society objected that the rotating action of the foreign bodies contained in the iron could only be effected at the cost of the combustion of a portion of the iron itself, as occurred in casting, and also, as he stated, happened in the case of Mr. Bessemer's apparatus.—*Mechanics' Magazine.*

NEW MODE OF JOINING PIPES.

MR. SIEMENS has exhibited at the Institution of Civil Engineers a machine of his invention, manufactured by Messrs. Guest and Chrimes, for Joining lead and other Pipes by pressure only. The machine consisted of a strap of wrought-iron in the shape of the letter V, and of three dies, two of which were free to slide upon the inclined planes, while the third was pressed down upon them by means of a screw passing through a moveable cross-head, embracing the sides of the open strap. The pipes to be joined were placed end to end, and a collar of lead was slipped over them. The collar was then placed between the three dies, and the pressure was applied, by means of a screw-key, until the annular beads or rings projecting from the internal surface of the dies were imbedded into the lead collar. The machine was then removed, and a joint was formed, capable of resisting a hydraulic pressure of 1100 feet. The security of the joint was increased by coating the surfaces, previously to their being joined, with white or red lead. The advantages claimed for this method of joining lead or other pipes over the ordinary plumber's joint, were the comparative facility and cheapness of execution, as the cost of a joint of this description was said to be only about one-third or one-fourth that of the plumber's joint. A machine of a similar description was also used for joining telegraphic line wires, a specimen of which was likewise exhibited by Mr. Siemens.

SPIRAL DRIVING NAILS AND BOLTS.

MR. M. WIGRET, of Exeter, has patented an invention, which he calls the "Patent improved Twisted or Spiral Fluted Driving Articles." Nails made on this principle prevent starting, and are said to be readily driven or twisted out, and they require no hole to be previously made. The idea seems to be a decidedly good one. The driving of such fluted nails and bolts into wood, reminds one of the way in which the Armstrong bolts are driven through the rifled interior of the cannon, only in this case the rotation of the bolt is effected by the fluting of the bolt itself, and not by any rifling of holes in the wood.

FILE-CUTTING MACHINERY.

MR. F. PRESTON and Mr. W. M'Gregor have patented certain improvements, consisting—1, in a mode of constructing the socket and joint of the chisel-holder in combination with a spring applied to the tail of the chisel-holder; 2, in holding the chisel rigidly between the jaws of a vice or clamp forming the chisel-holder, the chisel being held in its place in the vice or clamp by a pin, key, or a cottar; 3, in so constructing the cam for working the screw by which the table is moved, that after the table has been moved the necessary distance for cutting a fresh tooth, the action of the cam imparts a slight forward pressure on the table until the blow of the hammer has been given; 4, in the application of a friction clip or brake to the screw by which the table is moved; 5, in the application of a loose weight or weights to the top of the hammer; 6, in supporting the chisel-holder in a slide, in order that the chisel may be raised off the file in a line parallel to the cut.

Messrs. Greenwood and Batley, of Leeds, have recently imported a patent File-cutting Machine from France. The file is placed upon a self-adjusting bed, capable of being turned in any direction, and the chisel or cutting instrument is fixed in a vertical slide, acted on by a spring, and giving about a thousand blows per minute. The machine is under the control of the workman, and occupies very little room: it is said that it produces better files than can be made by hand labour, and will do ten or twelve times as much work as an ordinary skilled workman. The machine is already in operation in France and Belgium.

MANUFACTURE OF CAPSULES.

Mr. W. Munro has patented a new manufacture of Capsules and other metallic articles. He first prepares a sulphate of tin by placing 1 lb. of tin cut into thin strips in a bottle containing 2 quarts of water; to this he adds 3 lbs. of muriatic acid. He then filters the same through Dutch filtering paper into a vessel capable of holding 5 gallons of water. When the solution of tin is filtered, he adds to it as much soft water as will make, when mixed, 3 gallons of the solution. He then dissolves 28 ounces of common soda in 2 gallons of warm water, and pours it gently into the tin solution, when a white carbonate of tin will be precipitated. He then empties the vessel and washes the carbonate of tin in water and filters it through cotton, so that it becomes a thick paste, which he returns to the vessel previously used and emptied, and by mixing with it 3 gallons of water he brings the solution of tin into a fine cream-like condition. He then takes 2 lbs. of sulphuric acid, diluted in 2 gallons of water, and stirs the same into the previously prepared solution of tin, and thus a sulphate of tin will be produced. Having obtained the sulphate of tin he then places so much as may be required of it in a trough of wood or stone of a galvanic battery. He then takes pieces of the same size of the tin and of the lead, well cleaned on the surface, and places them in the trough face to face, the tin to be on the copper wire and the lead on the zinc wire of the galvanic battery, by which means and by the action of the galvanic battery—using to create the force 1 part of sulphuric acid to 14 parts of water—the lead will become coated with tin to any thickness required, and the combined metal may then be rolled down to a suitable thinness by ordinary flattening rollers or other suitable means. The sheets so produced may then be made into capsules, &c.—*Mechanics' Magazine.*

STEEL BELL-CASTING.

Messrs. Naylor, Vickers, and Co., of Millsands, have lately cast the largest Steel Bell which has yet been produced in Sheffield. The bell, which was designed by Mr. Roddewig, the engineer of the firm, is to be used as a fire-alarm bell in the city of San Francisco. A large iron vessel, plugged at the bottom, says the *Sheffield Independent*, was placed in the pit, above the mould, to act as a funnel, and the molten steel was poured into it from the crucibles. The moment that part of the process was finished, the plug was drawn from the bottom of the funnel by means of a crane. The fiery liquid then ran into the mould in a copious and uninterrupted stream, and the work of casting was complete. When the metal was sufficiently cooled to permit of an examination, it was found that all had gone right, and that the casting was perfectly sound. The weight is 2 tons 12 cwt., or 5824 lbs., and the dimensions are—Height, 5 feet 3 inches; diameter at the mouth, 6 feet 2 inches; thickness at the sound-bow (where the clapper strikes), 4½ inches. Messrs. Naylor, Vickers, and Co. cast their first bell in 1855, and have since turned out 1300. Steel is considerably cheaper than "bell-metal," and also stronger, so that a much smaller weight suffices for any required result, thus making the difference between the price of the two kinds of bells even greater than is represented by the difference in the cost of material per weight.

BRONZE DECIMAL COINAGE FOR CANADA.

THIS new Coinage has been completed at Her Majesty's Mint, and is of a highly artistic character. The new Canadian one cent is not only a representative of value, but of measure and weight. In value it is precisely the 100th part of the American dollar, or 1-24th of the English shilling. Its weight is the 100th of a pound avoirdupois, and its diameter is exactly, mathematically, 1 inch, or 1-12th of a foot. It is easy to see the value of these arrangements. On many occasions the coins might be used in lieu of avoirdupois weights, or as substitutes for the carpenters' rule and compasses, as well as for the circulating medium. It is perhaps the most scientifically contrived coinage, therefore, in existence. It is chaste in appearance, well engraved, and, being much harder than copper, will wear well. Twenty tons of these unique coins have been despatched to Upper and Lower Canada.

More than three millions of twenty, ten, and five cents, equal in weight and value to the French franc, half, and quarter-franc, had already been despatched. The bronze used is a mixture of copper, tin, and zinc—in the proportions of 95, 4, and 1—and this gives a metal harder and more durable than copper alone. The pieces are, in comparison with our own copper currency, thinner and larger in diameter. For instance, farthings are ⅞ths of an inch in diameter, and there are 96 of them to the lb. avoirdupois; but the Canadian one cents are just an inch across, and there are 100 of them to the lb. When it is considered, too, that they are current at the same value as the halfpenny, the economy of metal becomes at once apparent. The design of the obverse is chaste and pretty. Her Majesty's portrait, with the legend, VICTORIA, REGINA DEI GRATIA, CANADA, surrounded by an undulating wreath of maple leaves, comprises it. The reverse has a similar wreath, with the words, "One Cent," and the date, "1859," in the centre.

Meanwhile, there is little chance of the proximate adoption of decimal coinage for England. Lord Overstone by objecting with all the might of his authority to the introduction of the decimal system may be said to have delayed improvement in this particular direction *sine die*. The Decimal Coinage Commission has done much to enlighten the public as to the practicability of the decimal system of weights, measures, and notation, but apparently much more remains to be done.—*Mechanics' Magazine.*

INTENDED NEW COPPER OR BRONZE COINAGE.

IT is known that the Government intend to issue a new Coinage of a Bronze alloy, to replace the existing copper coinage; and we may now state that the arrangements have advanced so far that in Manchester there have been constructed the engines to drive the stamping presses to be used, and also the boilers needed for that purpose. The engines and boilers have been made by Messrs. R. Ormerod and Son, of the St. George's Iron-works, Chester-road, Hulme. The latter have already been forwarded to their destination, and the former will speedily follow. That destination is the works of Messrs H. Heaton and Sons, of Birmingham, who have, we are told, executed all the copper coins struck for this country for many years, and who also successfully competed for the execution of the new French currency issued by Napoleon III. The pair of engines are upon an improved direct action principle, and of 50-horse power; some patented arrangements of Mr. W. B. Johnson (who is connected with Messrs. Ormerod's establishment) being introduced. The frames are vertical instead of horizontal; it being supposed that strength and some other advantages are thus gained. The cylinders are of 20 inches diameter, the stroke being 4 feet. The fly-wheel has a diameter of 18 feet and weighs 13 tons; and the engines being intended to make from 36 to 40 revolutions a minute, the wheel will be speeded to 60 revolutions. The power will be given off from the axle, close to the fly-wheel, so that little or no checking strain should fall upon the engines. But as the metal to be used for the new coinage will be very much harder than copper, and as in striking coins from the latter metal the resistance will sometimes check, and even stop, the machinery, there have been special appliances added to these engines, which, by means of levers, will enable wheels to be slipped and the engines in effect thrown out of gear, while other levers will enable the working arrangement to be gradually and easily restored. The engines are beautifully finished. The two boilers are each 25 feet long and 5 feet 6 inches in diameter; with a 2 feet 9 inch circular flue, fitted for firing at each end, so as to secure more rapid production of steam, and an almost complete burning of smoke. The steam pressure is to be 60 lb. It is estimated that two or three years, at least, will be needed for getting in and replenishing the existing copper coinage.—*Manchester Guardian.*

In the *Mechanics' Magazine* have appeared several valuable papers upon the works at Her Majesty's Mint. From one of these communications we learn that the mechanical resources of the Mint, although exerted to an unprecedented extent lately, are found quite inadequate to supply the constant demand for money made upon that establishment; and that, consequently, an addition to the motive power employed has been made. A new steam-engine of 40 horse-power has been erected to drive the laminating machinery. Since the year 1810, when the first coin was struck in the existing Mint, an engine of 30 horse-power, supplied by Boulton and Watt, gave motion to this branch of the coining machinery; but, as has been said, the pressure for money is now so great that this very creditable specimen of early engineering is not equal to the task imposed upon it. The new engine was contracted for by Messrs. Hall, of Dartford, and is on the combined high and low pressure principle. It is placed side by side with its predecessor. The united power of the steam-engines employed in the cash department is 66 horses, reckoning that of the new money-maker.

BRONZE STATUE-CASTING.

A STATUE of the late Felix Mendelssohn Bartholdy has been cast in bronze for the Sacred Harmonic Society, by Messrs. Robinson and Cottam, of Pimlico, by the method peculiar to their establishment; for, while it used to be the practice to cast large statues piecemeal, by an improved plan they are now cast entire. The preparations consisted of a large iron case, bound and riveted together, and built on the floor, of such dimensions as to allow the reception of the full length figure in a horizontal position. Immense furnaces charged with metal were heated, and at a given signal an opening was made, and the liquid fire poured in one vast stream into a large iron cauldron, into which the contents of two other cauldrons from other furnaces were poured, to form the required composition of metal. This cauldron of mixed metal, containing nearly two tons, was then raised by machinery, and when immediately over the mould it was tilted into a large receiver, communicating with the mould beneath. A wheel was then turned, and immediately there was a gurgling and gushing of the flaming liquid through about fifty channels, conveying it simultaneously to every part of the figure beneath. After the lapse of a few minutes the workmen commenced knocking away the framework and black mould; but a day or two elapsed before the statue was completely cleared. The quantity of metal used in the statue is about a ton and a half; it will stand eight feet high, and will be elevated on a granite pedestal. It has been proposed to place this statue in the mall of St. James's Park, a site which, in our opinion, should be reserved for memorials which are strictly of national character.

TRUE ACTION OF "HEAT-DIFFUSERS."

MR. ARTHUR A. TAYLOR, of Marseilles, has communicated to the British Association the following paper:—Mr. Wye

Williams and others have found that an increased effect was produced by the fuel burnt in steam-boilers when what have been called Heat-Diffusers were placed in the tubes or flues. The apparatus in question consists generally of metallic bands or ribands twisted into spirals or bent in the direction of their length into zigzag forms, and placed in the tubes or flues, the professed object of this addition being to break up or disturb the current of heated gases passing through the tubes, and to cause every portion of the gases to impinge on the heating surfaces. The cause given for the increased effect produced being, that when a current of heated gases passes through a tube under ordinary circumstances, only the exterior portions of the columns come in contact with the sides of the tube, and that in thus disturbing the current by obstacles to its direct course, a more perfect contact of the gases with the surfaces is produced. The question which I wish to raise is, whether this is the true explanation of the effect produced by diffusers, deflecting bridges, &c. I think it can hardly be admitted that each molecule of a gas passing through a tube follows a course parallel with the axis, for those in contact with the sides of the tube will be so impeded by friction as to have a much slower motion than those in the centre, just as in a river the current near the banks is less rapid than that in the middle of the stream; and, that as in the river, so in the tube, a series of eddies will be formed, tending to bring all portions of the gas in contact with the sides of the tube. This peculiar motion of gases in a tube may very clearly be observed in the smoke issuing from the funnel of a steamer, the smoke retaining the eddying motion which it had in the funnel for some time after leaving it.

These considerations led me to consider the mere disturbance of the currents as inadequate to explain the increased evaporation observed, and to attribute it to a very different cause. Gases do not radiate the heat which they contain, so that the only mode in which a gas can communicate its heat to a surface is by contact or connexion. This is in the present practice the only mode in which those heating surfaces of a boiler which are not exposed to the radiation of the fire or flame, can abstract heat from the products of combustion; but if in a flue or tube a solid body be introduced, it will become heated by contact with the gases, and will radiate the heat thus received to the sides of the flue. Now these diffusers, &c., exactly fulfil these conditions, and I, therefore, attribute their effect mainly, if not entirely, to the function which they must fulfil in absorbing heat from the gases by contact, and then radiating this heat to the sides of the tubes or flues, and I think it will be admitted that the amount of heat thus conveyed to the water may be very important, when it is considered that the temperature of the gases in the tubes of a boiler at 5 in. or 6 in. from the fire-box tube-plates is about 800 deg. Fah., and that these radiators will consequently have a temperature of several hundred degrees above that of the surfaces in contact with the water in the boiler, and that a very active radiation must consequently take place from one to the other.

This principle once established, the modes of application in practice are, of course, endless, and I will only mention that I do not see any advantage in making these radiating surfaces of such a form as to impede the draught, especially in the case of marine boilers, but would rather choose the form which would give the greatest amount of radiating surface, and offered the least impediment to the free passage of the products of combustion through the tubes. Perhaps as effective a form as any for placing in the tubes of boilers would be a simple straight band of metal, or a wider band bent in the direction of its breadth, at an angle of 60°. In the case of marine boilers, they should be made so as to draw out easily, to enable the tubes to be swept. The economy of these "Heat-Diffusers" is thus illustrated:—Upon the 9500 miles of British railway there are now employed more than 5000 locomotives, performing an annual mileage of upwards of 90,000,000. The fuel consumed by these engines may be taken as equal to 1,500,000 tons of coke; and this quantity of fuel may be valued at 1,200,000*l*. The introduction of heat-diffusers in the above number of locomotive boilers would effect an annual saving of 400,000*l*., and involve no alteration in any of the existing arrangements.

HOT-BLAST OVENS FOR IRON FURNACES.

MR. H. MARTEN, of Wolverhampton, has read to the Institution of Mechanical Engineers a paper "On the Construction of Hot-Blast Ovens for Iron Furnaces," commencing with the origination and early development of the idea of hot blast by Mr. Neilson, of Glasgow, thirty years ago, and giving a description of the principal modifications and improvements that have been successively effected in the construction of hot-blast ovens. To remedy the defects still experienced, after many modifications, from expansion of the pipes, the round form of oven was then contrived; it has the fire-grate in the centre, and was surrounded by a circular main pipe, divided by a diaphragm all round into an outer and inner portion, on the top of which were placed a number of upright heating-pipes, each consisting of two pipes cast in one piece, and communicating with each other at the top, one leg of the pipe opening into the outer division of the main, and the other into the inner: the two sockets of each pipe being close together, and cast all in one piece, were thus freed from the injurious effects of expansion experienced in the previous arched pipes. The blast passed up one half and down the other half of each pipe; and the top of the oven was built in a dome shape, so as to reverberate the heat from the fire upon the pipes. These round ovens have since been elongated into an oval form, to contain a greater number of heating pipes; and a central core of fire-brick has been added, filling up the vacant space in the centre of the oven, bringing the heat into closer contact with the pipes arranged round the sides of the oven, and acting also as a regulator of the temperature of the blast, by absorbing any excess of heat from irregularity of firing, and giving it out again on any diminution of temperature. Hot-blast ovens on this construction, with some further improvements in the arrangements for cleaning out without stopping, have now been in constant work for some time at Mr. Marten's works, and have proved thoroughly satisfactory; being quite free from any trouble, either from expansion or burning of the pipes, or from leakage at the joints; the blast is maintained uniformly at a temperature of about 800° Fahrenheit, producing an important increase in the yield of the iron furnace.—*Mechanics' Magazine.*

IMPROVED GAS BAKING OVENS.

To prevent the injury to pastry, &c., from smoke and soot, complained of in reference to some of the modes of Baking by Gas, a new invention has been patented by Mr. S. Harrison, of Clare-market, in which the gas circulates with the smoke through the flue, in a serpentine direction, round closed ovens or compartments, two, three, or more of these being placed over each other, and separated by the winding flue; implanted in which latter is a gas jet for each compartment or oven, consuming the smoke from below, and sending its own to the next above, the remanent vapours having their exit at the top, so that no portion of them can have access to the articles in the several compartments; nor, indeed, can any one kind of these be tainted by the emanations from others in a different compartment or oven. The jets are seen to through side openings, with valves or doors, and the oven boxes have doors closing them in front of the stove. If only one oven be required, a single burner suffices, or if two, one for each, and so on. The heat is wholly confined to the stove, and so economized, that very little gas, it is said, will heat the whole.—*Builder*, No. 844.

GAS-LIGHTING.

THE process for generating Illuminating Gas has been greatly economized by M. Isoard, who has described to the British Association his New Mode of obtaining such Gas by means of Super-heated Steam and any Hydro-carbon; the process being carried out without the use of coal, but with the use of some resinous substance, such as tar. The mode is stated to be so economical that an apparatus of three-horse power would be able to light the city of Aberdeen, and the price is considerably cheaper than the gas in ordinary use.

THE FLUE PEDESTAL.

UNDER this title Mr. C. J. Richardson, the architect, has provisionally registered an invention for abating smoke in house chimneys. He proposes to wash the smoke by means of jets of water: it could be applied to every flue in a house, and the soot from the whole of them carried down to the drain. Of course this is aided by a new system of flues: unluckily, however, the quantity of water required is so great that it will prevent the application of the flue pedestal for this purpose to more than one or two flues in a building; but there is another service it performs, apart from its abating smoke, for which he expects it will be extensively used, and was not at first foreseen. Fully one-half of the heat from our domestic fires passes up the flues, and is lost in the atmosphere; whereas, the flue pedestal retains the greatest portion of this lost heat. Thus, placed in one of the upper rooms of a house, it becomes a hot-water pedestal, supplies warm water to the room, and moderately warms it by means of the fires in the lower parts or floors of the buildings, &c.—*Builder*, No. 830.

SUPPLY OF COAL.

M. DE CARNAL, one of the greatest owners of coal mines in Prussia, in a statistical work on coal digging, states that the quantity of Coal dug in 1857 amounted to 125,000,000 tons, a mass which piled up 6 feet high, would cover a geographical square mile. The lands from which the coal is procured may be estimated at 8000 square miles, and the mean depth of the beds of coal at about 31 feet. The mass of coal then known to exist would form a cube of 10 miles. If we compare this enormous bulk of coal with the quantity annually consumed, we may confidently affirm that there is enough to last for 36,000 years. The calculation of 31 feet for the mean depth of the beds is perhaps too low, for the coal fields of Liège extend 55 feet, those of Staffordshire to 151 feet, and those of Ruhr to 134 feet. The coal dug in 1857 amounted in value to 37,500,000*l.* sterling, a sum far beyond that realized by the digging of the precious metals. In England same calculations have been made with regard to the yield of coal in our own country, according to which the coal fields of Great Britain yield 63,000,000 tons of coal per year. A better idea of the immense commerce of England could not be formed than by stating the fact that at Manchester and its environs a motive steam power equal to 1,200,000 horses is constantly maintained, to support which there are consumed 30,000 tons of coal per day, or 9,500,000 a year. In the manufacture of salt alone about 3000 tons are consumed per day, or 950,000 a year. The Transatlantic steamers from Liverpool and other ports consume 70,000 tons per year, and the manufacture of gas absorbs 10,000,000 tons per year. The export of coal from England reached in 1858, 6,078,000 tons. It is estimated that England alone could furnish enough coal for the consumption of the whole of Europe for 4000 years.

GAS LIGHTED BY ELECTRICITY.

Two "sun-lights," each containing 75 burners, have been placed immediately under the ceiling in the centre of the Music-hall, in the Edinburgh University,—the ceiling being 40 feet in width, and 50 feet from the floor. These burners have been successfully lit by an application of the electric current. The galvanic battery is placed in the cellar, and from it positive and negative wires are carried up the side of the hall and along the ceiling, to immediately over the burners. Then it is coiled round the poles of an electro-magnet, to the keeper of which are attached a couple of wires bearing a platina wire. On the current of electricity being established at the battery, the platina wire, placed within an inch of the burner, becomes red-hot, and the gas being simultaneously turned on, the whole 75 lights, which are closely contiguous, immediately flash into flame. The electric current is then arrested, and the electro-magnet ceasing to be a magnet, its keeper, with the wires attached, falls 3 inches below the flame, so drawing down the platina wire out of the way of the flame of the gas. Lighting by electricity is by no means an unprecedented novelty.

WATER GAS.

ANOTHER, and it is said, successful, attempt at the production of Gas from Water for illuminating purposes, has been patented by M. Gillard, C.E., of Paris. He brings super-heated steam in contact with the decomposing material, and when the gas is produced it is purified by passing through hydrate of lime, either alone or mixed with carbonate of soda. The steam is super-heated by passing through tubes embedded in the brickwork of the furnace; and arrangements are made for the ejection of the steam upon the decomposing material in such a manner that this latter shall be kept equally heated. To impart luminousness to the hydrogen flame M. Gillard employs platinum wicks or wirework, or by preference wicks of any alloy of platinum and iridium. The inventor can impart to his gas, which is without any smell, any odour that might be required. The light is described as very brilliant. We quote these details from the *Builder*, a journal which records, with great regularity, the progress of gas-lighting.

THE SAFETY MATCH.*

IT will be seen by referring to the statistics of London fires during the year 1858, given in the *Mechanics' Magazine* of the 4th of March, 1859, that out of the 1114 fires forming the total of serious conflagrations, the following proportion was occasioned by the usual contrivances for procuring flame, viz:—

Children playing with lucifers	12
Lucifer matches accidentally ignited	7
,, ,, making	3
,, ,, careless use of	17
	39

In the first of these instances the sacrifice of life and wholesale destruction of property were traced principally to the fact of children inserting lucifer matches into various nooks and crevices, where an accidental concussion had produced their ignition. The next in the series of casualties are accidents resulting from the sudden ignition of boxes or bundles of phosphorized matches. The necessity as well as the possibility of removing the fatal cause of these accidents has long been felt; and by the following contrivance such occurrences, which hitherto have led to so many terrible disasters, may be completely obviated. This invention, which has reached us from France, consists of a match which cannot ignite by friction with ordinary substances, but which bursts into flame when struck upon a chemically-prepared substance, owing to the peculiar action occurring between the two bodies which are thus brought into contact. Without the prepared strip, the matches may be struck or trodden upon without the possibility of ignition. The advantage of having these articles tipped with a material which is not inflammable *per se* is sufficiently obvious, and we doubt not will recommend the "Safety Match" not only to careful housewives, but to the owners of large establishments where the ordinary "lucifers" are now used, and, we are afraid, often left carelessly about. The cost of the "Safety Match" is scarcely more than that of its less trustworthy predecessor. It is to be had of Mr. Twinberrow, chemist, 2 Edward-street, Portman-square, who is the sole agent in this country for the article.—*Mechanics' Magazine.*

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* See Hochstaetter's "Safe Matches," *Year-Book of Facts*, 1859, p. 69.

The reputed inventor of the Lucifer Match died during the past year in Stockton, aged 78. The *Gateshead Observer* adds to this announcement:—"In the year 1852 (August), correcting the history of 'matches' in the 'Jurors' Reports' (Great Exhibition), we stated, says our authority, that 'A quarter of a century ago, Mr. John Walker, of Stockton-upon-Tees, then (as now) carrying on the business of chemist and druggist in that town, was preparing some lighting mixture for his own use. By the accidental friction on the hearth of a match dipped in the mixture, a light was obtained. The hint was not thrown away. Mr. Walker commenced the sale of friction-matches. This was in April, 1827.' Dr. Faraday, it is said, first brought the discovery into general notice."

SIGNAL LIGHTS.

MR. FERDINAND SILAS has experimented with his invention at Blackwall, before a number of official and other persons, with great success. The experiments commenced at six o'clock, when a number of the floating lights, attached to lines, were cast into the Thames from the pier. On floating to the surface, the phosphoric substance of which they are composed suddenly burst into a blaze of light, and was only extinguished by being dragged under the water. The apparatus intended for the telegraphic light resembles a moderator table-lamp. This was placed on the jetty near the water's edge, and was operated upon by the inventor. In spite of the opaque fog, which completely enshrouded the river from bank to bank, the strong glare of the phosphoric light penetrated for some considerable distance, and was gratefully acknowledged by several boatmen, who would otherwise have had great difficulty in making the pier. Similar experiments were entered into in the presence of Admiral Gordon and the Brethren of Trinity House, together with the officers of the exploring ship *Fox*. It was then pronounced that the invention was extremely suitable for all the purposes above named, but they could not recommend the apparatus as applicable for lighthouses.

Mr. W. H. Ward, of Auburn, United States of America, has exhibited in Woolwich Dockyard his patent invention for transmitting messages, and carrying on correspondence of any length from ship to ship, becalmed, or sailing within telescopic sight of each other on the ocean, with equal facility to that of the electric telegraph on land. One of the instruments was erected at either end of a long enclosed lobby adjoining the dockyard factory, when a lengthened test of messages and replies was satisfactorily carried out. The experiment was extremely interesting and conclusive as to the merits of the apparatus, the result of which was promptly transmitted to Lord Clarence Paget, by special direction of Commodore Drummond to that effect, the invention having been pronounced one of the most important of the kind hitherto produced, and likely to be productive of immense benefit to the entire naval and merchant service afloat. The weight of the instrument, which is of the simplest construction, does not appear to exceed 14 lb. It represents the form of a cross, exhibiting five alphabetically marked lamps, which are worked by a process resembling the keys or notes of a piano slowly depressed, and at the termination of each sentence the lights are clouded. As regards the working of the instrument, the principal officers of the *Fisgard* who attended the experiments affirmed without hesitation that any boy of Her Majesty's fleet could obtain a perfect mastery of the system by two evenings' study.—*Times.*

Mr. Robson, of the Ammunition Laboratory, East Greenwich, has also in conjunction with Mr. Simon Holland, Admiralty draftsman, invented a new system of military and naval signals.

MAJOR FITZMAURICE'S NEW LIGHT.

THE Hon. Major has exhibited his newly-discovered Light in the Penrhyn Slate Quarry, near Bangor, with great success. The first experiment was conducted in a deep and long tunnel. The apparatus, which is quite portable, was placed at one end of the tunnel. The light produced from this was steady, pure, and so surprisingly brilliant that it completely illuminated the whole length of the tunnel, and rendered a written paper distinctly legible at a distance of 300 yards. The apparatus was next brought into the open quarry. Here also the results were most extraordinary. The numerous steps of the quarry, some even at a distance of 800 and 900 yards, were as clearly seen as in daylight. This light is applicable to a variety of purposes. The colours of furniture, dresses, &c., are rendered unusually vivid, and photographs can be taken in 10 seconds. It is free from injurious fumes, and consequently does not affect paint, gilding, or articles of delicate colour. It is also easily manufactured and very cheap. A light equal to that of 30 candles can be produced at a cost of one halfpenny an hour.

NEW LIGHT.

THIS new Light has been exhibited with great effect in the Crystal Palace at Sydenham. The light is obtained by a single jet of medium size and is found to be equivalent to 40 Argand or 80 fish-tail burners, each consuming five cubic feet per hour, or to 400 wax candles of four to the pound. With respect to the important question of expense, it was stated that the cost of maintaining the light was considerably less than any other known light, in the following proportion:—Oxyhydrogen lime light, 1*d.* per hour; coal gas, 4*d.*; argand oil, 15*d.*; wax candle, 60*d.* per hour. The larger portion of the transept of the Crystal Palace was illuminated by the new light, concentrated in a large disk, and its illustrative power was conveyed in a column of distinct rays to the spectator at the further end of the palace. The light was steady, brilliant, and diffusive. It is represented to be peculiarly adapted for coast lights, steamers, sailing vessels, railways, signals, bridges, wharfs, churches, factories, public rooms, squares, large and important thoroughfares. A very important application of the light is its adaptation to the mining service, by which the safety of the miner will be effectually secured by the enclosure of the light, and its supply with oxygen gas, without the necessity for direct communication with the surrounding atmosphere.

The new light is obtained by projecting a jet of oxygen and hydrogen, or oxygen and carburetted hydrogen gases combined, upon a surface of lime, and so regulating the supply and protecting the lime from crumbling away as to insure, with perfect continuity, a maximum brilliancy of intensity and continuity. For several years back the ingenuity of inventors has been directed to the discovery of a mode of lighting more economical, more convenient, and more powerful than that which we now possess by means of the generation of light from coal. The electric light, which has been frequently exhibited in London, was the nearest approach to a mode of lighting calculated to supersede the existing means of producing light from coal; but, though admitted to be extremely powerful, it was deficient in that steadiness, continuity, diffusiveness, and economy which could alone render it available for the practical purposes of life.

EXTRACTING COCOA-NUT OIL.

MR. S. PERKES has patented certain improvements in machinery for Extracting Oil from the Cocoa-nut, and other vegetable matters. Here the coprah is reduced into a pulp by a rotating rasp made up of circular saws, and such pulp is continuously fed on to an endless table or chain, which is reticulate, or made with suitable passages through for the passage of the oil. This endless chain or table is supported by several rollers on its under side, and the pulp of coprah is fed on to the same at the upper end of the machine, there being suitable mats or fabrics of cocoa-nut fibre, &c., on the under and upper surface of the vegetable matters so fed on to the endless table, which is arranged by preference in the form of an inclined plane from the upper to the lower end of the machine. The part of the endless chain or table for the time out of action passes under the supporting rollers, and there are trays under the supporting rollers to receive and conduct off the oil to suitable receivers. The endless chain or table in its movement over the supporting rollers passes under a number of pressing rollers, there being one such roller over each supporting roller. The first or uppermost pressing roller is at the greatest distance above the table or endless chain, so as to offer comparatively little pressure to the vegetable matters on the table, and the rollers in succession are set nearer and nearer to the endless table or chain, by which as the table or chain progresses, the matters thereon become subjected to greater and greater pressure. The rollers are made hollow so as to be heated by any suitable hot fluid or otherwise, and in some cases the pressing surfaces of the rollers are of glass. In order to separate the fluid oils from foreign matters, centrifugal machines are employed.—*Mechanics' Magazine.*

MODE OF PROTECTING TIMBER FROM FIRE.

A PAPER, by Mr. F. A. Abel, has been communicated by Dr. Cleghorn to the Botanical Society of Edinburgh. After mentioning various methods which have been adopted to render wood less combustible, by saturating it with solutions of phosphate of soda, and muriate or sulphate of alumina and chloride of calcium, the author remarks that all that can be reasonably expected from the most efficient protective coating or impregnating material is—1. That it should considerably retard the ignition of wood exposed for some length of time to the effects of a high temperature, or of burning matter in its immediate vicinity. 2. That if the vapours which the wood emits by continued exposure to heat become ignited, the flames thus produced shall not readily affect the fibre of the wood, and shall cease almost directly on the removal of the wood from the source of heat. 3. That the prepared surfaces of wood when in actual contact with burning unprepared wood shall have little tendency to ignite, and thus cause the fire to spread. The plan proposed is to impregnate wood with silicate of soda, and to coat its surface with a silicate. The impregnating of the wood is effected by putting it in a solution of the silicate. The surface of the wood is then washed over with a somewhat diluted solution of the silicate of soda. After an interval of at least two hours, a coating of thick limewash is applied over the silicate; and finally, on the following day, a strong solution of the silicate is applied over all. In this way a protective covering is given to the wood. The process may be used with benefit in the case of timber employed for wooden huts.

FIRE-PROOF COMPOSITION TO RESIST FIRE FOR FIVE HOURS.

DISSOLVE, in cold water, as much pearlash as it is capable of holding in solution, and wash or daub with it all the boards, wainscoting, timber, &c. Then diluting the same liquid with a little water, add to it such a portion of fine yellow clay as will make the mixture the same consistence as common paint: stir in a small quantity of paperhanger's flour paste to combine both the other substances. Give three coats of this mixture. When *dry*, apply the following mixture:—Put into a pot equal quantities of finely pulverized iron filings, brickdust, and ashes; pour over them size or glue water; set the whole near a fire, and when warm stir them well together. With this liquid composition, or size, give one coat; and on its getting dry, give it a second coat. It resists fire for five hours, and prevents the wood from ever bursting into flames. It resists the ravages of fire, so as only to be reduced to coals or embers, without spreading the conflagration by additional flames; by which five clear hours are gained in removing valuable effects to a place of safety, as well as rescuing the lives of all the family from danger. Furniture, chairs, tables, &c., particularly staircases, may be so protected. Twenty pounds of finely sifted yellow clay, a pound and a half of flour for making the paste, and one pound of pearlash, are sufficient to prepare a square rood of deal boards.—*Builder.*

A NEW FIRE-ESCAPE.

MR. JOHN OTTIGNON, of 59, High-street, Bloomsbury, has provisionally registered a new Fire-Escape, which consists of a metal cradle or basket, to be retained within a balcony screen at a window, and slung by means of a chain or rope, passing over pulleys and a miniature crane, and running through the house, either to the back premises, or from floor to floor, to a heavy counter-balance weight to which it is fastened. Another chain or rope is attached to the bottom of the basket, in order to be thrown into the street, to enable those present to aid in either pulling down the basket, swerving it to some other window, or keeping it off projections. Except when in use, the escape is hooked to the balcony, and the chains are kept in the bottom of the basket. How the counter-balance is disposed of, ready for action, however, does not appear from the specification; but of course it can readily be kept slung with a portion of the chain attached, the junction with the escape portion being easily effected near the escape itself.—*Builder.*

MILITARY COOKERY.

IN the *Year-Book of Facts*, 1858, p. 101, we described Capt. Grant's successful plans for the application of heat to Cookery for the Army on an extensive scale. In August last, some interesting proofs of the efficiency of the apparatus were shown upon Dartford Heath by the Royal Artillery, who had proceeded thither from Woolwich garrison. Under the new system of cooking on the road, the exercise of marching out in lieu of parade and field drills is now readily adopted, and it has been issued as one of the garrison regulations, to take place one day in each week, the weather permitting, in order to inure the men to the fatigues of a campaign, and to familiarize them with the new method of preparing their rations on the road. The ambulatory cooking waggons having been previously prepared under the superintendence of Capt. Grant, the fires were kindled, and the process of cooking commenced with the march. They arrived at Dartford at a quarter past twelve, preceded by the regimental band, and immediately began to pitch their tents in preparation for dinner and rest. The travelling kitchens were drawn up in an appropriate spot, and the process of "serving up," without the necessity of delay, immediately commenced in the same manner as in a permanent kitchen. Lady Dacres and other ladies were present, and partook of some of the soup, drawn from the general cauldron, which was pronounced excellent. Gen. Dacres expressed his opinion of the apparatus in the most eulogistic terms, and the whole body of officers, as well as a number of visitors present, who were enabled to exercise their judgment, pronounced, without hesitation, that the merits of the invention were incontestably proved. The quantity of wood consumed was shown to be one-tenth of the ordinary amount allowed by Government—namely, 150 lbs. in lieu of 1500 lbs., the ordinary consumption. Capt. Grant, who is a retired officer of the Royal Artillery, actuated by a philanthropic desire of benefiting the soldier, has passed many years of anxious study in perfecting his various cooking apparatus, the merits of which have been at length tardily acknowledged. Several of the pontoon cooking kettles were also in use upon the above occasion on the heath. The dinners supplied were ready to serve out in an hour and a half after the fires were lighted, and water was boiled in six minutes and a-half. An improvement has been effected in this method, by adopting a longer trench, and thereby affording a more available current of air to keep up the fires. The trenches were 16 feet long for the 16-inch ketles, 15 inches wide, and 16 inches deep. The three feet kettles contain 27 gallons, and with 10 kettles dinners have been cooked for 1000 men. Some of the kettles were served by temporary turf chimneys, in which case the trenches were 18 feet long.

NEW COOKING APPARATUS.

A DUBLIN correspondent of the *Builder* (an architect), thus describes a Patented Apparatus of Mr. Radley, of Dublin. It will roast, boil, bake, stew, fry, and steam, it is said, all at the same time, with considerably less fuel than is now required for the best constructed range hitherto used, and in a much shorter space of time. The construction is described as being simple, and not liable to get out of order. It has an enclosed jack for roasting, which is made to rotate with the smoke current of the fire, spring weight, or steam (or it can be worked by the hand), the principle being self-acting. The boiler can steam large quantities of vegetables, &c., and at the same time heat several gallons of water.

EXPLOSIONS IN POWDER-MILLS.

MR. F. O. WARD has laid before the Manchester Philosophical Society his plan for diminishing the liability of Powder-Mills to Explosion, and referred to a correspondence between himself and Dr. Faraday on the subject. The plan in question consists in supplying, to those portions of powder-mills in which the powder is treated dry, an atmosphere incapable of supporting combustion—preferably carbonic acid gas—so as to obviate the danger of explosion so far as it arises from chances of ignition *ab extra*, as by the spark from a workman's pipe, of which an example was cited. The danger of explosions from the liberation of oxygen from the powder itself, by friction or otherwise, would, of course, remain; but this, the author inclines to believe, is a less frequent cause of explosion than ignition *ab extra*, occasioned by the carelessness of workmen, rendered indifferent to risk by long habit, and emboldened by impunity. Dr. Faraday, in his comments on this plan, approves it as adapted to cut off one class of risks, so to remove the point of danger further off, and also as not likely to deteriorate the quality of the powder immersed in the protective atmosphere. He points out, however, as a source of danger usually unsuspected, the possibility of the ignition of the gunpowder dust which collects on the beams of powder-mills, and by which, he believes, explosions may be originated, as well as by the heating of the grains actually under trituration in the mill. Mr. Ward, in reply to Dr. Faraday, recognises the partial nature of the security afforded by the proposed plan, but lays stress on the fact that it appears adapted to eliminate all the risks of the manufacture except those which are inherent in the nature of the material operated on, and therefore essentially incurable.

GUTTA PERCHA.

WE gather from the Annual Report of the Society of Arts that the Gutta Percha Committee has met several times, and is carrying out systematically its experiments.* The Committee have had under their consideration the properties of the substance called "Pauchontee," an Indian gum, alluded to in the Council's Report of last year as the produce of a tree of the same genus as that from which the true gutta percha is produced. This substance has been carefully analysed and experimented upon, and a report as to its nature and properties has been sent, as requested, to the Indian Government. For this Report, and the experiments and analyses, the Society are indebted to Mr. Dugald Campbell, one of the members of the Committee. From this document it appears that at the ordinary temperature it is hard and brittle, but upon the addition of heat, such as that caused by friction in a mortar, it becomes sticky and viscid, and when once this condition is reached, it does not after the lapse of several days assume its original consistence. When boiled with water, it becomes of a reddish-brown colour, rendering the water turbid and slightly saponaceous. Experiments were made with a view to compare the properties of the gum with those of gutta percha. For this purpose, the comportment of each, when brought into contact with various chemical re-agents in similar conditions, was particularly noticed, and the results are shown in a table accompanying the report. With some of the re-agents, the behaviour of the gum is precisely similar to that of the gutta percha, while with others only a slight similarity is to be observed. Both seem to be nearly soluble in fuming nitric acid, while ordinary nitric acid and dilute nitric acid produce a similar re-action on both. In no one case can there be said to be a decided difference. Further experiments were made by dissolving similar quantities of gutta percha and gum in equal portions of naphtha and turpentine respectively, and after pouring the solutions from the sediment, allowing them to evaporate at the ordinary temperature of the atmosphere. After standing to evaporate the solvent, the gutta percha in each case had returned to its original condition, while the gum was soft and sticky, except when submitted to a considerable degree of cold, when it became brittle and friable as at first. From these results it will be seen that the gum alone could not be used for similar purposes to which gutta percha is applied. Experiments were made in order to ascertain how far the gum could be mixed with gutta percha without interfering to any great extent with the properties of the latter ; and mixtures were made containing 5, 10, 20, 30, 40, 50, 60, and 70 per cent. of the gum and gutta percha. From an examination of these mixtures it would appear that from 20 to 30 per cent. of the gum may be added to the gutta percha without any material difference being noticed in the mixture to the gutta percha alone. But it is necessary to observe that these mixtures have not been put to the test of sunlight, air, &c., which are known to decay gutta percha more or less, according to the nature of the gutta percha (gutta percha not being a perfectly definite substance) and the time it may be exposed, as their application may have to extend over some years before a result could be obtained of any value.

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* For the announcement, see the *Year-Book of Facts*, 1859, p. 68.

COVERINGS FOR FLOORS.

THE production of a good, durable, and cheap covering for floors, embracing the advantages of softness and elasticity, has long been sought for. Carpets, whether of Brussels or Kidderminster, are expensive, and soon show signs of wear, besides which they are not adapted for halls, offices, or public buildings. To meet this want a composition called Kamptulicon has been extensively introduced in churches and other places, but after trial has been discarded as useless, on account of its extreme brittleness—or, perhaps, "*shortness*" would be a better term—as after it has been down for some time it breaks or crumbles, on being taken up, very much like oat-cake. This may be a defect that possibly in time might be overcome by experimenting with the composition of which it is made, though most likely the result would be a hard compound. We have made these remarks to introduce a very beautiful invention especially designed for the purposes in question. The patentee is Mr. Dunn, of Messrs. Charles Goodyear and Co. (the inventor of the vulcanization of india-rubber), for combining a mixture of cork, cotton, wool, and other fibrous materials of any colours and fineness with india-rubber, and spreading them upon a canvas, cotton, or woollen back, which is then subjected to a process by which the carpet in embryo can be embossed, either plain or in colours, the result being a material of great permanence and beauty.—*Builder*.

VEGETABLE LEATHER.

THIS artificial substitute for real leather is manufactured by

Messrs. Spill and Co., on Stepney Green. Its face and general character resembles the natural product so closely, that it is only by actual examination that the difference can be determined. This is more particularly the case in that description which is made for book-binding, the covering of library-tables, and like purposes. Amongst other advantages it possesses over leather proper, is that however thin the imitation is, it will not tear without considerable force is exercised; it resists all damp, and moisture may be left upon it for any period without injury; consequently, it does not sodden or cockle, is always dry, and its polish is rather increased than diminished by friction. To scratch or raise its surface with the nail, or by contact with any ordinary substance, will not abrade it; and enough will have been said to justify its entering the list against an article of daily use, which has of late years been deemed far from sufficient for the demand, and has consequently risen in price to the manifest loss and injury of every class of the community. We believe that the largest entire piece of real leather that can be cut from a bullock's hide is not more than 7 feet by 5, and this includes the stomach and other inferior parts. Vegetable leather, on the contrary, is now produced 50 yards in length and 1¼ yards wide, every portion being of equal and of any required thickness, and the smallest portion is convertible. Caoutchouc and naphtha are used in its manufacture, but by a process known to the senior of the firm, who is himself an accomplished chemist, all odour is removed from the naphtha, and the smell of vegetable leather is rendered thereby less in strength, if anything, than that of leather. The principal objects to which it is at present applied, are carriage and horse aprons, antigropolo, soldiers' belts, buckets which pack flat, harness of every description, book-binding, &c. For the latter, its toughness, washable quality, and resistance to stains, render it remarkably fitted. Its thickness, which may be carried to any extent, is obtained by additional backings of linen, &c., cemented with caoutchouc, and its strength is marvellous, while it is but one-third the price of leather.—*Mechanics' Magazine.*

A SELF-SUPPORTING BRACKET.

Every one knows how the principle of atmospheric pressure is illustrated by a toy called a sucker, which boys make with a bit of wet leather and a string passed through its centre: the principle has been applied in an analogous manner as the means of fixing a piece of metal in a moment to a wall, a ceiling, or the glass of a window. "Lavater's Patent Pneumatic Bracket" is a short brass tube, having at one end sockets in which may be inserted any sort of light frame, branches, or hooks, and terminating at the other extremity in a trumpet-like expansion, which is covered with a disc of india-rubber. To the centre of this disc is attached a smaller one cf metal, which can be drawn within the tube by a screw proceeding from a cap that fits over the smaller end of the tube. When the screw is relaxed the india-rubber disc is flat. Apply it then to the wall after moistening it with the breath, turn the screw, and the metallic disc, receding from the surface of the wall and carrying the central portion of the india-rubber with it, will create a vacuum capable of sustaining a weight proportioned to the superficial area of the trumpet-like expansion. The bracket may be detached in a moment, and will leave no mark, it is said, where it has been. By means of a similar contrivance any number of brass rods may be attached to the glass in a shop window without breakage.—*Builder*, No. 851.

SECURING CEILINGS.

A PATENT has been taken out for securing the plastering of Ceilings and Walls. The object is to cause the first layer of plaster to adhere as firmly to the laths as the second layer does to the first; and for that purpose it consists in applying to the joists or grooves, or to a ceiling of boards, laths having inclined edges forming an angle with the horizontal plane of the floor, to which the mortar is to be applied, and spread on in the usual manner, so that the tongues of mortar which pass between the interstices of the laths form an angle with the horizontal plane of the floor, and overlap the tops, and are clinched thereto, whereby the mortar is held and prevented from falling.—*Builder*, No. 835.

ABERDEEN GRANITE.

AT the late Meeting of the British Association at Aberdeen was read a "Description of the Granite Quarries of Aberdeen and Kincardineshire," by Mr. A. Gibb. The working of the quarries in Aberdeen commenced 250 years ago; but little progress was made for 100 years. The houses in Aberdeen were constructed principally of wood till 1741, when a fire taking place, the town-council ordained that the fronts of the houses should be of stone or brick. In 1764 granite was recommended for paving the streets of London, and was used for Waterloo Bridge in 1817, and subsequently for the docks at Sheerness and London Bridge. There are upwards of 20 quarries supplying the different varieties of granite: the blue, the red or Peterhead granite, the light red, soft grey, and white. The granite, for the most part, lies in irregular masses in the quarries, and generally of columnar structure. The quarrying is principally carried on by blasting. The drainage of the quarries is chiefly accomplished by means of siphons of lead-pipe, from 1 to 2 or 3 inches in diameter. The author suggests the use of a locomotive engine on rails for drainage purposes, as well as for crane and lifting work. The quarries are not worked to any great depth, though the best and largest masses are found at the lower depths; and proper mechanical contrivances for working deeper might be used with advantage. With reference to the durability of the granite, there appears no appreciable decay; on the oldest specimens of several hundred years the tool-marks are as sharp and fresh as at first. The tools used in dressing the granite for a long period were hammers, picks, and axes only; but in 1820 steel chisels were introduced, which effected a considerable improvement. Machinery was tried for dressing, but it failed, being in the form of a planing machine, the granite requiring a distinct blow to separate the parts. The number of workmen employed in the quarries is about 500 daily, and the number of horses about 50. About 50,000 tons are quarried annually, of which about 30,000 are exported; and the export is increasing at the rate of 500 tons annually.

WATER-GLASS AND ITS APPLICATIONS.

An important Report on this useful agent has been translated and printed for private circulation, at the instance of His Royal Highness the Prince Consort, as President of the Society of Arts; but, we regret to add, that in this document the claims of a British inventor to priority have been entirely ignored. The inventor is Mr. Frederick Ransome, who writes:—

"The articles upon the subject of Water-glass, by Dr. Fuchs, which have recently appeared, and the Report of the Commission of the French Government on the experiments of Professor Kuhlmann, would lead to the conclusion that the important subject of Silicification and the various applications of soluble glass are comparatively unknown in this country, the more so as no reference whatever is made, either in the Report, or the articles in question, to English discoveries and manufactures dependent upon the same principles.

"As the inventor and patentee of various processes, in every respect analogous and almost identical with those suggested in the articles alluded to—as having, during the last fifteen years, occupied myself exclusively in modifying and improving the manufacture, and applying successfully on a large scale the soluble glass to various useful purposes previously unknown in this country, I may be allowed to claim attention to the great injustice of bringing so prominently forward as a novelty the history and results of experiments conducted by foreign chemists in the manufacture and use of a material for which *I received the Telford medal of the Institution of Civil Engineers in* 1848; *a prize medal from the Jury of the Great Exhibition in* 1851; and which I have been manufacturing at the rate of many tons per week at my own works, and more lately at those of the Patent Silicious Stone Company at Ipswich.

"My own attention was first directed to the subject in the year 1844, when carrying out a series of experiments with a view to the production of an artificial stone suitable for grinding, building, and ornamental purposes, which should possess all the advantages, and be free from many of the defects of the natural stones hitherto in use.

"I was not at that time aware of the memoirs published by Dr. Fuchs, in Kastner's *Archiv* for 1825; nor of the further researches either by him or Professor Kuhlmann; nor have I yet learned that either of those gentlemen attempted, or even contemplated, the manufacture of stone by such process; but, on the other hand, I may be allowed to state that I secured a patent in France for this very process in the year 1845.

"In the year 1845, I obtained letters patent in England, Scotland,

and Ireland, for the application of a soluble silicate for combining small coal into blocks, and for preserving wood from fire and decay.

"In the year 1854, and still without any knowledge of the work done by Dr. Fuchs or Professor Kuhlmann,* I invented a process for 'preparing oxides and carbonates of lead or zinc,' and 'carbonates or sulphates of barytes with soluble silica,' either with or without being 'mixed with colouring or other matter,' and enrolled a provisional specification, intending to complete the patent for the same, but owing to an attack of illness, I was prevented from obtaining this protection.

"In the year 1855, I claimed and obtained a patent for further improvements in the manufacture of artificial stone; and lastly, in 1856, I invented and patented a process for preserving natural or artificial stone and other building materials, and in rendering them less liable to decay.

"The application of this process, which I also patented in France, in March, 1857, has, in every instance in which I have operated, been attended with the most satisfactory results; decay has been prevented in the softest and most friable stones, and where disintegration had commenced prior to its use, this has been at once arrested, and the same stones rendered perfectly hard and durable."

At the late meeting of the British Association, Mr. Ransome described more in detail the value of the above applications in the manufacture of artificial stone, and in the preservation of natural stone, &c., from decay.

The latter process consists not merely in the application of a soluble silicate, as described and adopted by Professor Kuhlmann and others on the Continent, and which Mr. Ransome stated he found to be utterly ineffective in this country, being liable to removal by rain or even by the humidity of the atmosphere—but consists, first, in treating the stone, &c., with a solution of silicate of potash or soda, and afterwards with a solution of chloride of calcium, or chloride of magnesia; by which means a double silicate, or silicate of lime, or silicate of magnesia, is immediately formed in the pores and structures of the stone, &c., which double silicate possesses the most indestructible and most strongly cohesive properties, enveloping every particle of the stone with which it comes in contact, producing an extraordinary amount of hardness, and hermetically sealing all the pores with an indestructible mineral precipitate, without in the slightest degree destroying the natural characteristics of the stone.†

Every impartial person must regret that "the French Government Commission" should have prevailed upon the Society of Arts to sanction the circulation of a document which inflicts such a wrong upon one of the Society's most active and intelligent members. In the *Athenæum*, considerable attention has been paid to this subject, and the respective claims of the methods of M. Kuhlmann and Mr. Ransome, with the following results :—

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* See *Journal of the Society of Arts*, No. 348.

† See a paper on M. Kuhlmann's invention in the *Year-Book of Facts*, 1859, p. 65.

> "We have taken some trouble (says the *Athenæum*, No. 1671) to inquire how far M. Kuhlmann's process for preserving stone by the simple application of the soluble silicate or 'water-glass,' on the surface of buildings already erected, is successful.
>
> "We hear that not only at the Houses of Parliament in this country, but that also in Paris, in those portions of the Louvre and Notre Dame which were experimented upon with the water-glass, the result has been inefficient and unsatisfactory. The hardening of the film by the action of the atmosphere, although a possible result if time and circumstances are favourable, has failed in practice, owing in part to the facility with which the water-glass or silicate is removed by the moisture.
>
> "Mr. Ransome's process consists in the application of a solution of muriate of lime, which immediately enters into combination with the silica of the water-glass, and forms silicate of lime—a perfectly tenacious, insoluble, and indestructible substance, which completely fills up all the interstices and pores of the stone, &c., rendering it impermeable and non-absorbent.
>
> "The great desideratum, unquestionably, has been to find some means of rendering stone impermeable, without the introduction of oily or fatty matter; or, in other words, by means of some substance that cannot be decomposed or injured by exposure either to the oxygen of the air, or to any of those vapours so commonly mixed with the air in large cities or in manufacturing districts.
>
> "Mr. Ransome's idea, of fixing a coat of silicate of lime, by taking advantage of the double decomposition that takes place when chloride of calcium comes in contact with silicate of soda or potash, both dissolved in water, seems to have settled the question. The discovery has not had so long a test as may be considered desirable before pronouncing on its merits. There is reason to be satisfied so far as we have gone.
>
> "The comparison of those parts of the Houses of Parliament treated in this way, or the Baptist Chapel at Bloomsbury, or other buildings submitted to the process, with any of those specimens of stone treated either by M. Kuhlmann's or other process, will show any observer how much the advantage is in favour of the more scientific, and at the same time simple method.
>
> "We have often alluded to the progress made with this material, and find that our conviction of its value is strengthened as time goes on. It will be interesting to watch the application of the preserving process to the buildings in Paris and elsewhere, where the simple solution of the soluble glass has been found to fail; and we understand, that not only is this about to be done, but that M. Dumas has already lent the sanction of his great name to the soundness of the chemical question involved therein."

DRY CLAY BRICK AND TILE MACHINERY.

At the Royal Agricultural Society's late show at Warwick, there was exhibited by Mr. H. Chamberlain, a machine patented by Messrs. Bradley and Craven, by means of which Bricks, it is said, can be made from perfectly Dry Clay, so that when moulded, they can be taken direct to the kiln to be burnt. Mr. Chamberlain says :—

> "Brick-making has been hitherto carried on during a limited season of some six months in each year, or during the long days, as the bricks could not be dried in the winter, and frost would totally destroy them. The result of such a system presses very hard upon the brick labourer, who only finds full employment for one-half his time. Again, a large stock of bricks is obliged to be made, to meet the demands for the winter months, and if trade is not very flourishing the manufacturer has to hold them, or sell them at a great sacrifice. On the other hand, it often occurs that works are seriously delayed in the spring, from the make of the previous year being exhausted, and no further supply can be obtained until the new bricks of the current season are ready for use. The dry clay machines meet these emergencies, for all they require is a shed in which the clay may be stored as it is raised from the earth, a machine-house, and kilns. If the clay-shed holds sufficient material for a month or six weeks' consumption

the works can be kept on uninterruptedly during the whole year, giving constant employment to the labourer, and enabling the manufacturer to meet any demand. In districts of the country where coals are cheap, the bricks are dried on flues throughout the winter; or where my improved brick-works are erected, they are dried, both in winter and summer, by the waste heat of the burning kilns. In the use of flues the consumption of fuel is considerable for this purpose, and therefore greatly increases the cost of manufacture. The saving of labour in making the bricks of dry clay is immense. When made in a plastic state, the clay must be tempered and worked, at great labour, into a perfectly homogeneous mass, and after manufacturing the bricks they have to be spread on drying-floors, or walled on drying ground, to evaporate the water that it has taken so much trouble to thoroughly mix and work into it. As the drying ground for a large work is necessarily extensive, the labour of the several removals must entail a costly process, while on the dry-clay making nothing more is necessary than to throw the rough earth into the machine, when it is delivered out a perfect brick for removal to the kiln at once for burning. In practice it is found advisable with strong clays to use a portion of sand with the earth, the same as in plastic clay manufacture. The pressure can be regulated to anything desired, so that bricks can be made of the densest description for engineering purposes, or they may be made of as open a texture as the hand-made brick, by giving less pressure, and the addition of sand to the clay.

"For fire-brick making these machines are particularly adapted, and in case of existing works that have proper grinding-mills, the machine only is neces-

MANURING CROPS.

There has been communicated to the British Association a "Report on Field Experiments on the Essential Manuring Constituents of Cultivated Crops," by Professor Voelcker. These researches, which extended over a period of four years, had special reference to the turnip-crops. Dr. Voelcker described the plan upon which these experiments were undertaken, and mentioned the results which were obtained. Amongst other points of interest to the agriculturist, it may be noticed, as the result of four years' experience in the growth of turnips under particular conditions,—1. That fertilizers destitute of phosphoric acid do not increase the yield of this crop. 2. That phosphate of lime applied to the soil in the shape of soluble phosphate (superphosphate) increases this crop in an especial manner, and that the practical value of artificial manures for root-crops chiefly depends on the relative amount of available phosphates which they contain. Thus it was shown that 3 cwt. of superphosphate per acre produced as large an increase of turnips as 15 tons of farm-yard manure. 3. That ammoniacal salts and nitrogenized constituents yielding ammonia on decomposition, have no beneficial effect upon turnips, but rather the reverse. 4. That ammoniacal salts applied alone do not promote, as maintained erroneously, the luxuriant development of leaves; but that they produce this effect to a certain extent when salts of ammonia are applied to the land in conjunction with the mineral constituents found in the ashes of turnips. The Report likewise states that numerous analyses of turnips have been made, from which it appears that the more nutritious and least ripened roots invariably contain less nitrogen than half-ripened roots, or turnips of low feeding qualities. In the latter, the proportion of nitrogen was found in several instances two to two-and-a-half times as high as in roots distinguished for their good feeding qualities.

Similar experiments upon wheat showed that nitrogenized ammoniacal matters, which proved inefficacious in relation to turnips, increase the yield of corn and straw very materially, and that the increase of wheat was largest when the ammoniacal constituents were associated with mineral matters.

THE FORCES USED IN AGRICULTURE.

MR. J. C. MORTON has read to the Society of Arts an able practical paper on this subject, in which he remarks:—

Agriculture is experiencing the truth taught in the history of all other manufactures—that machinery is, in the long run, the best friend of the labourer. This truth is taught even more impressively by a review of agriculture generally, than it is by the case of any individual farm. Here are we, twenty-one millions of people, producers and consumers, living in this island, on a great farm, which we may, by the help of such statistics as we possess, describe as nearly 19,000,000 arable acres, and probably nearly as much grass, employing as farm labour, in-door and out, about 950,000 men and 120,000 women, besides 300,000 lads and 70,000 girls, or averaging them by their probable wages, as has been done before, let us say equal in all to 1,150,000 men, or one to every 17 acres of arable, and nearly as much pasture. We feed and use some 1,500,000 horses, of which probably 800,000 are strictly for farm purposes. We are annually inventing and manufacturing labour-saving machines at an extraordinary rate, and every year at least 10,000 horses are added to the agricultural steam-power of the country, certainly displacing both animals and men to some extent. We have taken the flail out of the hand of the labourer, and the reaping-hook is going; on many a farm he no longer walks between the handles of the plough—he no longer sows the seed—he does but a portion of the hoeing and the harvesting—and yet, so far from being able to dispense with his assistance, he is more in demand than ever.

Within the past ten years upwards of 40,000 horse power has been added to the forces used in agriculture in steam alone. If I may single out Messrs. Clayton and Shuttleworth of Lincoln, Garrett of Saxmundham, Hornsby of Grantham, Ransome of Ipswich, and Tuxford of Boston, they alone are furnishing 10,000 horse power annually to the farmer. Messrs. Tuxford, among the first to start the locomotive agricultural steam-engine, inform me that for the earliest suggestion of it they are indebted to Mr. John Morton, of Gloucestershire, then agent to the late Earl of Ducie, who twenty years ago recommended them to put these little engines upon wheels, thus foreseeing the fitness of these powers made locomotive to the circumstances of English agriculture. Messrs. Ransome, of Ipswich, were, I believe, the earliest to receive the commendations and the prizes of the Agricultural Society of England for their engines, and now the leading manufacturers of them, Messrs. Clayton, of Lincoln, send out ten of them each week, or 4000 horse power per annum.

Of reapers, again, since 1851, Burgess and Key have sold upwards of 1900 of their improved M'Cormack's reaper, of which 771 were sold in 1858; and they now hold four times as many orders as they did twelve months ago. Crosskills have sold 500 of Bell's reaper, and 800 of Hussey's; Messrs. Dray have sold 800 of their improved Hussey's reaper; Messrs. Garrett have sold 600 of Hussey's; 250 of Wood's clever little reaper were sold in 1858; and the Cuthberts, of Bedale, who have just begun the manufacture of their equally clever machine, sold 100 before last harvest, and could have sold four times as many. In all, probably 4000 reaping machines were at work last harvest, capable of cutting more in a day than 40,000 labouring men, and yet there never was such a harvest as the last for the difficulty of procuring harvest men. Notwithstanding all this addition to the forces and the machinery of agriculture, more labourers than ever are required, and as more labourers are not forthcoming, wages rise. Thus the increase of steam-engines and machines need create no fear for the agricultural labourer.

If fears and lamentations have any place at all, it is in behalf of the masters rather than of their men. The labouring force in agriculture is better paid than it used to be.

Tens of thousands of acres have been this autumn ploughed or worked by steam.

That the services of the labourer will more and more require the combination of skill with mere force, and that a larger number of well-qualified men is being, and will be, needed, seems plain. That horse power will be displaced by steam at least two-fifths, I believe: and, as there are now at least 800,000 horses used upon our farms, there is scope enough for many years to come for all our agricultural mechanics.

The grand result will, no doubt, be a continual increase of produce and fertility.

BOYDELL'S AND BRAY'S TRACTION ENGINES.

THE capabilities of this admirable Road Locomotive have been tested in Hyde Park, previous to the engine and its train of waggons being despatched to Bombay, in accordance with the wish of the Secretary of State for India. The engine, though less compact than that known as Bray's patent, is nevertheless as beautiful a machine, perfectly under control even for the sharpest turnings of ordinary streets, and easy both in ascent and descent of steep inclines. Both patents are fitted with the peculiar mechanism over the driving wheel which forms an endless tramway. In the engine of Boydell this endless rail acted with the most perfect satisfaction, quite bearing out what has been before stated, that the engine could not only travel over the worst roads, but that the roadway itself is actually improved by the equal and broad compression of the rails. Though nominally of 12 horse power, the boilers yield steam for an indicator of more than double their amount, and the engine can with ease draw from 60 to 70 tons along ordinary turnpike roads at the rate of four miles per hour. Attached to the machine were five powerful waggons specially made for the purpose by Crosskill, and all of which, by removing a pin or pivot from between the two leading wheels, are enabled to follow every turn of the engine with a serpent-like movement which gives the utmost freedom and flexibility to the whole convoy. More than once the whole train turned in less than half its length, and that, too, in passing over grass and uneven ground. The indentation made by the passage of the wheels was no more than would have been made by an ordinary coal waggon. 160 soldiers of the Guards were in attendance and rode in the waggons, and with this load the whole train was taken easily across the level parts of the Park at the rate of six miles an hour. The results of the trials were in the highest degree satisfactory, and seem to leave no doubt whatever that over the rough roads of India during the summer season, when the rivers are dry, the engines will be of the utmost service in facilitating the transmission of merchandize. For military purposes, such as getting up guns and siege stores, an engine of the kind would prove an invaluable auxiliary.

One of Bray's Traction Engines, denominated the "steam horse," manufactured by Mr. Taylor, of Birkenhead, for special use to supersede the employment of teams of horses in the removal of timber and other materials, ordered by the Board of Admiralty for service in the dockyard, Woolwich, has been tested at various rates of speed, and driven repeatedly round, forming a circle of about sixty feet in circumference. It afterwards proceeded along the principal thoroughfare of the yard at a speed of eight or ten miles per hour, and was subsequently handed over to the authorities. The engine, unlike any former one, is fitted with carriage springs to reduce the amount of friction, which would otherwise be considerable, from the effect of the stony and uneven roads over which it is destined to travel.

NEW PLOTTING SCALE FOR SURVEYING LAND.

MR. J. G. AUSTIN has explained at the Institution of Civil Engineers a "Double Off-set Plotting Scale," for the use of civil engineers, land surveyors, &c. The invention was described to consist in the projection of the line upon which the plotting was to be performed, at a distance from the edge of the scale, by means of the "station pointers," so as to admit the smallest off-set being plotted on either side of the scale. The instrument was readily affixed to the paper and board, by placing the "station pointers" upon the line to be plotted upon, keeping the scale in use always on the left hand, and the lower pointer exactly at the station from which the line proceeded. Then, by turning the milled-headed screws at each end, the instrument was fixed immovably during the operation of plotting. Should the length of the line exceed the capacity of the scales, the distance plotted must be denoted on the map, the instrument released by reversing the screws, shifted forward, refixed, and the work continued ; but should the line be shorter than the capacity of the scale, the position of the instrument could be determined by the zero line of the off-set scale, without the necessity of extending the line to the length of the instrument. The scales could be adapted to suit the operator, could be made of any material in customary use for such purposes, or the principle could be adapted to any existing scales. The off-set scale was intended to traverse between the edges of the lateral scales, and the distance upon the line was to be determined by the edge, and the off-sets plotted on either side of the zero line. The instrument was said to be simple in its use, to save much time in the operation of plotting the details of railway and general surveys, to insure accuracy, and avoid the possibility of error from shifting, and as the surface to be plotted upon could be seen, it enabled the smallest off-set to be denoted on either side of the line with greater ease and correctness than by the customary mode.

A SEVERAL-BLADED AXE FOR STONE DRESSING.

AN ingenious and simple Axe has been invented by Mr. James N. Douglass, resident engineer of Small's Lighthouse Works, Solva, near Haverfordwest. Four to six blades are ranged side by side in this instrument, all being fitted and fixed in the socket or head by means of nuts and screws. The wrought-iron socket weighs 7½ lbs. and a set of cast-steel blades 9½ lbs.; the whole weighing 17 lbs. The axe has been in use on a granite sea-tower connected with the works, and is said to be very effective, and to realize a saving of 25 per cent. over the common granite axe for fine work. The four blades are used for the first axing, and the six for finishing.

SELF-WINDING CLOCKS.

MR. JAMES WHITE, of Wickham Market, has now in operation "a Self-winding Clock, which determines the time with unfailing accuracy, and will perpetuate its movements so long as its component parts exist." This (says the *Builder*) reminds us of a self-acting clock (if we may so call it) which we saw many years since, with a brass ball which traversed in a zigzag route along a groove in a brass plate mounted on an axis, the force of the ball in motion striking a latch or check at each end as it descended, and upsetting the incline somehow, so that it just began again to traverse as before, till it struck the latch or check at the other extremity. It was said that the only unavoidable stop to this continual self-action was the wearing out of the apparatus.

A KEYLESS LOCK.

THE impossibility of rendering a strong box altogether safe against theft by means of skeleton keys has led a locksmith in Frankfort-on-the-Main to hit upon the ingenious idea of constructing a strong box without any keyhole at all, and which even the owner himself cannot open. Why, what's the use of such a box? you will ask. But, observe, inside is a clockwork, the hand of which the owner places at the hour and minute when he again wants to have access to the box. The clockwork begins to move as soon as the lid is shut, and opens the lock from the inside at the moment which the hand indicates. Time, dependent upon the owner, is the key to the lock-a key which can neither be stolen from him nor imitated.

MANUFACTURE OF CLOTHING BY MACHINERY.

IN evidence given before the Army Contracts' Commission, Mr. Peter Tait, of Limerick, has stated that the whole of his clothing is cut and sewn by machinery driven by steam, and capable of making 4000 suits a-week. It is owing to the encouragement he has received from Sir Thomas Troubridge, at the War Office, that he has carried the practical application of machinery so far. He could now clothe the whole of the British army, assuming that 250,000 suits would be required annually; and, on an emergency, with the steam-power at his command, he could furnish 100,000 suits a-week to the Government. He employs about 1100 people, and no man at wages lower than a guinea a-week.

The *Boudoir Sewing Machine*, patented by Messrs. Newton, Wilson, and Co., is thus described: This machine is designed to execute all ordinary domestic sewing, and adapted also for all light manufacturing purposes. It is mounted on a portable table, and motion is imparted by means of a treadle acting on a small friction-wheel under the machine. This arrangement enables the machine to be protected from injury, as the box or cover in closing detaches the machine from its treadle. The friction-wheel drives two small levers, one above and the other below the body of the machine. The upper one carries the piercing needle, and at the same time feeds the machine with its work, and carries it forward, regulating also, by a screw in the front, the length of stitch as may be desired. The under lever carries the looper or little instrument used in completing and securing the stitch on the under side of the fabric. There are two of these loopers connected with the machine. The one is simply a hook; and where the needle passes through the cloth, lays hold of the loop of thread, and retains it till the needle, passing again through the cloth, enters this loop and leaves another, drawing the first tight in its receding motion. The stitch thus made is that known as the tambour stitch. By changing the first looper, and substituting the second, a different stitch is formed. The hook of this looper has a longer point than the other, with an eye formed to carry a second thread; and the needle and the looper, by alternately intersecting the threads they respectively carry, form an interlocked or chain stitch on the under side. On the face of the fabric the appearance of both stitches is alike, that of a back stitch. The thread is taken direct from the bobbin, and the stitch in each case is elastic, and therefore not liable to injury in washing or ironing. By adaptations which are attached at pleasure, the machine is made to turn down, fold, and hem, at the same time, also to lay and stitch binding on to the edges of a garment.

BREAD BY MACHINERY.

MACHINERY for the Making of Bread has lately been introduced into this country by Mr. Miller, a baker in Upper George-street, Edgware-road, who also adopts some modifications of the usual process of preparing the dough. The machinery comprises a mixing machine, a kneading machine, and a machine for forming the loaves.

The mixing machine consists of an iron cylinder, through which a horizontal axis passes, having a series of beaters, or blunt knives, fixed at right angles to it. Each knife or beater is bent round, in the form of an oblong parallelogram, which extends from the axis to within a short distance of the inner surface of the cylinder. The cylinder is steadfast, while the axis carrying the beaters revolves inside. The materials for making the bread are placed inside the cylinder, and in a very short time, by the action of the machine, they are thoroughly mixed. The kneading is performed by passing masses of the mixed material, after it has stood a sufficient time, through a pair of steel rollers several times, and thus it becomes kneaded and thoroughly amalgamated into a uniform dough, suited for passing into the next machine, which forms it into loaves. This machine consists of a sloping platform, which delivers the dough into a pair of steel rollers working horizontally at the end of it, capable of adjustment to any suitable distance. Beneath those rollers revolves an endless web, which, by means of a simple mechanical arrangement, is carried step by step the exact space required for the cutter, which stamps out the loaves from the dough in succession, as it is carried along the web in a thin uniform sheet. The pieces of dough thus cut, which are not more than three-quarters of an inch thick, are set side by side on flat tins, and placed in a warm atmosphere for about thirty or forty minutes, until the dough has risen somewhat, when they are put in the oven. The modified process for making the bread is as follows:—

The dough, after it has been mixed and kneaded in the usual way for making bread, is kept in fermentation for about six hours or more, until it has reached the acetous state, and become unfit for use in the ordinary process, when there is added to it one-fifth of its weight of dry fresh flour, and without any additional water it is mixed and broken rapidly and very thoroughly through rollers, cut and pierced in a cutting machine, or by other means, and after a slight fermentation in an uncovered state exposed freely to the air, say for thirty to forty minutes, according to the temperature of the room, to raise it, baked in a quick oven, which should be ventilated by an open door or other means of admitting and discharging the air freely. In making the dough, about ninety-five pounds of water to two hundred pounds of flour are used, and from this weight there result usually two hundred and eighty-two pounds of baked bread. The invention is applicable in making bread from any kind of flour of which bread may be made, and is said to produce the same beneficial result in the use of all kinds.

The inventors do not confine themselves to the precise details above described, as such may be varied or modified without departing from the principle of action thereof; but they claim as new the process of allowing the dough to ferment till it passes into the acetous state, then reviving it by working and breaking it into fresh dry unfermented flour, afterwards cutting and piercing it, and raising it while exposed freely to the air, and baking in an open or freely ventilated oven.

The mixing cylinder in use at Mr. Miller's is sufficiently large to take half a sack of flour at a time. The whole of the machinery is driven by a small steam-engine of 2-horse power.

The machinery and process generally are American inventions, and form the subject of patents in that country as well as in this.—*Journal of the Society of Arts.*

NEW MODE OF MAKING BREAD.

Dr. Odling has described to the British Association his new Bread-making process, by which the carbonic acid is produced independently of, and superadded to, flour, which consequently undergoes no modification whatever. The carbonic acid gas is stored in an ordinary gas-holder, and is pumped therefrom into a cylindrical vessel of water, whereby the water becomes charged with gas. This soda-water is mixed under pressure with the flour, and the resulting dough becomes vesicular on removing the pressure. It is then divided into loaves and baked. This process is so rapid that in an hour and a half from the first wetting of the flour, a sack of flour is made into two-pound loaves. The advantages of this new mode are —its cleanliness, from the beginning to the end of the operation, neither the flour nor the water is touched by the human feet; it conduces to the health of the work-people; it is a very rapid process; it is certain and uniform; and it prevents any deterioration of the flour, so that by this process you can use flour which would require alum in the ordinary process.

MACHINERY FOR MAKING BOOTS AND SHOES.

MR. ARCHIBALD NEILSON, of Glasgow, has invented an improved apparatus for making Boots and Shoes. The main portion of the apparatus used consists of a shoe sole, the upper face of which is formed to a fine surface corresponding to the sole and heel to be moulded. This sole face is channelled all round the contour for receiving a corresponding frame of metal hinged at one end to the sole plate, and in pieces, if convenient. This frame has upon its upper face an angle or ledge-piece for forming the seam at the junction of the sole with the upper of the boot or shoe, whilst its main inside edge face shapes the external contour of the sole edge. The workman takes the lasted boot, and having deposited solution or softened gutta-percha upon the face of the sole, he places the lasted "upper" down upon it, and then shuts down the open moulding frame. This at once moulds the sole, firmly attaches it to the edges of the lasted leather, and completes the operation. If required, the heel portion may also have an open moulding-frame.

PLANING MACHINE.

THE Banff Saw-mill Company have in their premises a machine for planing and jointing wood, driven from the same shaft as the saws. The Planing Machine is on the usual principles. It has a cast-iron frame about 3½ feet in height and 12 feet in length. Four feeding rollers draw the deal into the machine endways; and immediately after it enters, it passes over three planing irons in succession, which are set angularly, about four inches apart, with their edges upwards. The board is next caught by the irons which make the groove and feather on its edges. These are set in upright shafts, which revolve about 4000 times per minute. The next and concluding operation is the roller which revolves above the board, having two blades in it, which chip off whatever of the board is above the proper thickness. Thus prepared, deal after deal is thrown out—planed on one side, grooved and feathered, and all brought to one uniform thickness—ready for laying.—*Builder*, No. 830.

SUBSTITUTE FOR RED LEAD.

An invention, based on the discovery and application of a certain earth or ochre, to which the name of Burgundy red has been given, has been patented for Messrs. Bouchard and Clavel, of Paris. This Red Ochre is very rich in silica and alumina, and is found on the estate of La Gruerie, in the Commune of Fontenouille, Canton of Charney, department of Yonne, France; but as it is probable that ochre of the same or very similar quality may be found in other parts, the inventors wish to reserve to themselves the application of such earths or ochres in general to the preparation of the substitute for red lead. The composition of this ochre (Burgundy red) is:—Silica, 50·00 parts; oxide of iron, 14·50 parts; alumina, 26·60 parts; carbonate of lime, 7·60 parts; sulphate and phosphate of lime, magnesia, loss, 1·30 parts; = 100·00. A cement may be prepared with this earth which may be used with considerable advantage as a substitute for red lead in making the joints of boilers, water and gas-pipes, and other joints, by mixing the said earth with grease, oil, lime, and with fragments of unburnt earthenware, Roman cement, and chalk in about the following proportions:—Burgundy red, 66 parts; grease or oil, 15 parts; lime, 11 parts; unburnt earthenware, chalk, or Roman cement, 8; = 100. This Burgundy red, or other analogous earth, may also be used very advantageously as a coating for preserving metal to prevent oxidation, by diluting it with volatile oil.—*Builder*, No. 830.

TRADE MARKS.

A paper has been read to the Society of Arts, "On Trade Marks," by Professor Leone Levi. The author points out the importance of the British manufacturer continuing to maintain the high character he has gained in the markets of the world; and for this purpose it is necessary not only that no deterioration should take place in the quality of the articles produced by him, but also that no idea should gain currency that such deterioration had taken place. The imitation of a trade mark is illegal in this country, though there are cases in which the law has been evaded, some of which were mentioned. In some foreign countries, however, such palpable frauds take place, owing to the imitation of many of our trade marks, that serious loss, both of profit and character, is sustained by the British manufacturer. The country where this might almost be said to have become a system was Prussia; and whilst our English courts of law give the fullest remedy to the German manufacturer against similar attempts here, there are at present no legal provisions in Prussia against this grievance. France has already entered into treaties with various other Powers to prevent such proceedings, and it is incumbent upon the Government of this country to use every endeavour to remedy this serious evil.

A NEW AERIAL SHIP.

In a number of the *New York Times* for September, 1859, we find described a new Air-Ship, named the *City of New York*, in progress of construction by Mr. Lowe, a New Hampshire man, who has made thirty-six balloon ascents; and in this vast machine he hopes to cross the Atlantic. The following are stated to be its dimensions:—Greatest diameter, 130 feet; transverse diameter, 104 feet; height, from valve to boat, 350 feet; weight, with outfit, 3½ tons; lifting power (aggregate), 22½ tons; capacity of gas envelope, 725,000 cubic feet. The *City of New York*, therefore, is nearly five times larger than the largest balloon ever before built. Its form is that of the usual perpendicular gas-receiver, with basket and lifeboat attached. Mechanical power is to be applied; a new arrangement of revolving fans has been devised; and the material of which the envelope is composed is covered with a peculiar varnish, the invention of Mr. Lowe.

Six thousand yards of twilled cloth have been used in the construction of the envelope. Reduced to feet, the actual measurement of this material is 54,000 feet, or nearly 11 miles. Seventeen of Wheeler and Wilson's sewing machines were employed to connect the pieces, and the upper extremity of the envelope, intended to receive the gas-valve, is of triple thickness, strengthened with heavy brown linen, and sewed in triple seams; the pressure being greatest at this point.

The netting which surrounds the envelope is a stout cord, manufactured from flax. Its aggregate strength is equal to a resistance of 160 tons, each cord being capable of sustaining a weight of 400 lb. or 500 lb.

The basket which is to be suspended immediately below the balloon is made of rattan, is 20 feet in circumference, and 4 feet deep. Its form is circular, and it is surrounded by canvas. This car will carry the aëronauts. It is warmed by a lime-stove, an invention of Mr. O. A. Gager, 1½ feet high and 2 feet square.

Dropping below the basket is a metallic lifeboat, in which is placed an Ericsson engine. Its particular purpose is the control of a propeller, rigged upon the principle of the screw, by which it is proposed to obtain a regulating power. The propeller is fixed in the bow of the lifeboat, projecting at an angle of about 45 degrees. From a wheel at the extremity 20 fans radiate. Each of these fans is 5 feet in length, widening gradually from the point of contact with the screw to the extremity, where the width of each is 1½ feet. Mr. Lowe claims that by the application of these mechanical contrivances his air-ship can be readily raised or lowered, to seek different currents of air; that they will give him ample steerage way, and that they will prevent the rotary motion of the machine. In applying the principle of the fan, he does not claim any new discovery, but simply a practical development of the theory advanced by other aëronauts, and partially reduced to practice by Charles Green, the celebrated English aëronaut. It is estimated that the raising and lowering power of the machinery will be equal to a weight of 300 lb., the fans being so adjusted as to admit of very rapid motion upward or downward. As the loss of three or four pounds only is sufficient to enable a balloon to rise rapidly, and as the escape of a very small portion of the gas suffices to reduce its altitude, Mr. Lowe regards this systematic regulator as quite sufficient to enable him to control his movements and to keep at any altitude he desires. It is his intention to ascend to a height of three or four miles at the start, but this altitude will not be permanently sustained.

The sanguine projector expected, according to the *New York Times'* report, that he would certainly go, and, as certainly, would go into the ocean or deliver a copy of Monday's *Times* in London on the following Wednesday. He proposes to effect a landing in England or France, and will take a course north of east. A due easterly course would land him in Spain, but to that course he objects. He hopes to make the trip from this city to London in forty-eight hours, certainly in sixty-four hours. As the upper currents, setting due east, will not permit his return by the same route, he proposes to pack up the *City of New York*, and take the first steamer for home.

The air-ship will carry weight. Its cubical contents of 725,000 feet of gas suffice to lift a weight of 22½ tons. With outfit complete its own weight will be 3½ tons. With this weight 19 tons of lifting power remain. The company is limited to eight or ten. In case of danger, great reliance is placed upon the life-boat. These are the most rational details from the *New York Times*, if we except the first line of the closing paragraph—"*The precise time for the first ascension has not been fixed.*"

EXPLORATION OF AUSTRALIA BY BALLOONS.

MR. H. COXWELL, of Tottenham, designer and constructor of the balloons ordered in this country by Mr. G. Copping for use in Australia, gives the following account of the balloon explorations in Australia:—The balloons now at Melbourne were built simply for public amusement. The aëronauts, however, who went out, in accordance with Mr. Coxwell's recommendation, were requested to make frequent meteorological observations, both in the higher region and lower currents, especially with a view of observing how far it is likely a balloon would be influenced by inland and return breezes. Mr. C. H. Brown, assisted by Mr. Dean, is now making the required observations, and from the accounts already received there appear to be good grounds for believing that certain reliable currents will facilitate the undertaking. As a matter of course, an expressly-built machine, of ample dimensions, will be requisite, together with every conceivable appliance, to afford a return journey by a diametrically opposite wind to that embraced at the outset. The party will also be provided with an improved and gigantic fire-balloon, in a collapsed state, which can be inflated in the most desolate interior locality without gas, a reserve expedient, which in the event of injury or exhaustion to the parent machine will provide the means for a second trip. Mr. Coxwell is also maturing a totally novel apparatus, to regulate the altitude of the exploring balloon, so as to avoid the continual loss of gas and power resulting from extreme variations in the atmosphere. This contrivance will bring the aërial vehicle under a larger amount of mechanical control. The expedition will be provided with a photographic apparatus for obtaining a series of bird's-eye views, the correctness of which will be invaluable. Viewing calmly the danger likely to accompany such an attempt, I do not think it can fairly be pronounced greater than that which attends an arctic voyage, or any other which originates from a desire to attain useful knowledge by intrepidity and personal risk.—*Mechanics' Magazine.*

HATTERSLEY'S NEW TYPE-COMPOSING MACHINE.

THIS machine, the invention of Mr. Hattersley, of Manchester, is thus described by Mr. Henry Bradbury, of Whitefriars:—

Unlike previous attempts in the construction of machines for this purpose, Mr. Hattersley's is at once simple and compact, not liable to derangement, delicate, but strong, and not requiring that type should be cast with special grooves for the purpose.

The machine consists of a horizontal table, divided into channels of sufficient width to allow the type to slide freely. At one end of these channels is fixed a metal slide, against which, by a vulcanized india-rubber cord, the type is constantly pressed, and held with sufficient force to prevent the last one in each channel from falling through an aperture immediately under it. Under these apertures is fixed what is termed the Guide Plate, fitted with downward channels directly under, and corresponding with, the apertures. These channels verge, for the delivery of the type, into one common mouth, which is immediately over the Stick Holder, in the shape of an inclined plane. A modified Composing Stick is adjusted to the Stick Holder, in which it is made to slide longitudinally. The machine is furnished with keys, arranged as near to the present system of compositors' cases as possible. Each key, marked with the letter it represents, is connected with a piston or pusher, situated immediately above the face of the last type in the upper (horizontal) channels. The action of the key is to push the last type through the aperture leading into the Guide Plate, thus liberating the type, when its own gravity causes it to descend through the channels of the Guide Plate into the compositors' stick: as each type drops, it is guided into its place in the stick, which at the same time is pushed longitudinally forward, thereby making a place for the next descending type. A vulcanized india-rubber spring raises each piston into its original position as soon as pressure is taken off the key. Towards the end of each line a bell gives a signal, enabling the operator to judge how many more types he may play into the stick before justifying out, as in the ordinary way, the stick being in a convenient position for such purpose.

The channels of the horizontal table are calculated to hold a quantity of type equal to that contained in two pairs of ordinary cases. To avoid delay, arising from the channels becoming exhausted, the machine is provided with extra supply tables, which can be charged in a few seconds. The average speed as yet attained by the youth who has been practising upon the machine, may be said to be 4000 letters per hour, from reprint copy, including the justification. To bring it into operation would involve a systematic division of labour, as follows:—

1. Distributing type by hand.
2. Classing type, *i.e.*, arranging letters of the same character in rows.
3. Charging tables with classed type.
4. Composition.

Distributing, classing, and charging the tables, are mere mechanical operations, and can be done as well by youths as by adults. Composition, from MS. or reprint, however, is an operation necessarily of a higher kind, but still capable of being done equally as well by the one as the other labour.

The following statement, comparing the old with the new system, is an example of what might be realized from the employment of machines. The calculation has been made simply with reference to the cost of the number of letters composed—and quite independent of all other extras to which all works more or less are subject, in the shape of making up, &c.

The Extra or Advertisement sheet of the *Times* consists of 8 pages of Ruby type. The composition amounts to 1,029,888 letters, or 205 galleys, at 4s. 3d. each, or 43*l.* 12s. Whereas, by the new system the same number of galleys could be composed for 14*l.* 14s.; this multiplied daily, or 313 times, would yield a difference of 9045*l.* 14s. in the year.

Again, *Knight's English Cyclopædia* consists of 488 sheets or 7804 pages, of Brevier type. The composition amounts to 83,770,000 letters, or 83,770 at 6d., or 2094*l.* 5s. Whereas by the new system the same number of thousands could be composed for 930*l.* 13s., yielding a difference of 1163*l.* 12s.

These results have been based upon the employment of six machines, eighteen intelligent youths, at 15s. per week, and one machine superintendent at 2*l.* 10s. The youths are qualified for either description of work—distributing, classing, charging, or composition—and are, therefore, able to relieve each other at the composing-machine. It has been ascertained that, to sustain the speed of 4000 letters per hour, a youth, or adult, would require change about every three hours.

The introduction of the one system for the other would be at first attended with a certain amount of inconvenience; the two instances given, however, show that, sooner or later, the type-composing machine will be adopted by necessity, and will have the same relatively proportional advantage over hand-composition as the printing-machine has had over the hand-press.—*Journal of the Society of Arts.*

YOUNG'S TYPE-COMPOSING MACHINE.

MR. J. H. YOUNG has patented certain Improvements in Setting up, Composing, and Distributing Types. These improvements in setting up types relate chiefly to the composing machine patented by the inventor in 1840, in which an inclined plane is used for collecting the different types as they are required at one point; but they are also applicable to the machines in which moveable belts are used as a collecting medium. The inventor now claims :—

1. The application of apparatus for obtaining a regulated alternate movement and stoppage to the stop-wheel. 2. The application of apparatus for obtaining a regulated alternate movement and stoppage of the types upon the inclined plane, in order to insure their being properly taken off. 3. Making the steps of the stop-wheel moveable. 4. The raising of the types at the termination of the inclined plane of the same, and the regulated action of the pusher so that it may not strike at an improper movement. 5. The application of electro-magnetism for regulating the taking off the types of the inclined plane, and their delivery into the receiver. 6. The application of a small auxiliary composing machine, which may be fixed to, or detached from, a larger or other composing machine. 7. The partial covering of the channels down which the types slide on the inclined plane. 8. The application of a groove for small bodied type in the bed of the channel of the inclined plane used for a larger bodied type. 9. The application of a pusher through the aperture or apertures so constructed in the inclined plane to allow of superfluous types falling off the same. 10. The application of moveable blades to effect the distribution of types by means of their nicks as described.

IMPROVED PRINTING-OFFICE.

Mr. Henry Dawson, the architect of several important buildings for commercial purposes in New Cannon-street, and elsewhere in the city of London, has erected for Mr. Clay, the very able printer, a large Block of Buildings which extends from Bread-street-hill to Fye-Foot-lane. Throughout this new office, ventilation and sanitary precautions are kept in view; the machinery and contrivances in the several floors are entitled to special notice; and the entire establishment contrasts strangely with the bad construction and dilapidation so common in the old printing-offices of the metropolis.

The external walls at Mr. Clay's new office (says the *Builder*), which are of brick, are faced with yellow malms, varied with red brick in arches, courses, cornices &c., with stone sills and weatherings. The three fronts of the rear portion of buildings above the basement story are constructed entirely of cast-iron, so as to obtain the maximum of light. The basement story is made partly fireproof, for the reception of stereo-plates, &c. The steam-engine and boilers are on this story. The floor of machine-room on the ground story is constructed with brick arches and iron girders. Pits are formed in this floor under each machine, by counter arches and wrought-iron plates. The upper floors are constructed on cast-iron columns and wood girders. The roof is of iron and wood, and left open, with a large amount of skylight. The timbers of floors and roof are wrought, stained, and varnished. There is a steam lift passing through the several stories, which was supplied by Messrs. Hopkinson and Co. The building is heated by hot-water apparatus, supplied by Mr. J. R. Peill.

SURFACE-PRINTING.

Mr. H. G. Collins has patented certain improvements in the production of Blocks or Surfaces to be used in Printing. Here the drawing, device, &c., is obtained on a block or surface to be used in printing, from a drawing, device, or matter on a lithographic stone or other surface, whether the same has been produced thereon by hand, transferred, or otherwise, by subjecting the drawing, device, or matter on the lithographic stone or other surface to a series of processes similar to that in which a lithographic stone is inked when about to be printed from in the ordinary manner; but the ink or composition used is to be mixed with suitable driers, so that each succeeding coating of the composition may quickly dry or set before the next coating is applied. By these means, the lines and parts constituting the drawing, device, &c., on the stone, which would be inked and printed from if used in the ordinary manner, become more and more built up or raised, and when such raising has been sufficiently accomplished, a cast in wax or other suitable material is taken, from which an electrotype is obtained, as is well understood.

A Company has been formed for the purchase and working of this patent. The specimens produced by the above process are bold and effective illustrations, and appear to be specially adapted for printing on pottery, &c.

SURFACE-PRINTING FROM ENGRAVED PLATES.

MR. HENRY BRADBURY, of the eminent printing firm of Bradbury and Evans—a gentleman whose beautiful system of "Nature printing" has charmed us all—has introduced a new method of producing Printing Surfaces from engraved plates. He describes it thus:—A composition is spread over an engraved plate in order to get a cast, and from such cast an electrotype plate is obtained. The composition consists of gutta percha and animal grease, or oil, or vegetable oil (by preference hard or olive oil is used). The gutta percha is combined with the grease or oil by means of heat. The composition is kneaded and washed in warm water, and then the water is completely pressed out. The composition is laid on a plate, and heat is applied to the under or back surface of the engraved plate, so that by melting the composition the whole of the engraved parts may be filled. The coating of composition thus applied is, when dry or set, to be removed, and from it an electrotype plate is to be produced, as is well understood, but in place of resorting to the ordinary means of preparing the surface of the cast taken from the engraved plate, it is preferred to wash the surface of the composition cast over with a solution of the nitrate of silver, and then to subject the same to the vapours or fumes produced from phosphorus and caustic potash.

UNIVERSAL PRINTING-PRESS.

M. SILBERMAN, pupil and assistant in physics to the late M. Savart, has patented a Press upon Pascal's law, which is as follows:—

"Whatever be the amount of pressure brought to bear upon any point in a contained fluid mass (whether the fluid be a liquid, or steam, or gas), this pressure is distributed with perfect and entire equality among all parts of the mass, and consequently with perfect equality over all parts of the surface of the vessel which contains the mass;" so that if this vessel or a portion of it be pliable and elastic, it will communicate the same pressure which it receives to paper, cloth, or any other similar substance, laid upon an unyielding engraved surface. And the invention consists in printing by thus applying the pressure of a fluid to a yielding surface laid against an unyielding engraved surface; and this whether the surface printed be that of the vessel itself, which thus becomes the press,—or whether it be communicated to another interposed yielding surface from the pliable and elastic side of the vessel, so as to print plane, curved, or angular surfaces,—or whether the material to be printed be paper, felt, textile fabric, caoutchouc, leather, bladder, ceramic paste, or glass, crystal, or enamel softened by heat,—or whether it be used for the purpose of peripheric printing, as in the printing of terrestrial and celestial globes, of vessels of glass and earthenware,—or as a modification of the presses in use for other kinds of printing.

The following is one of the methods for the practical application of the principle:—

A strong shallow basin of tough metal is required, with a triple stop-cock at bottom, admitting at pleasure the sort of fluid intended to be used, whether it be atmospheric air, steam, or (when great pressure is required) water, with hydraulic pressure. This basin is filled with water, and covered by a tympan formed of a sheet, or of several sheets thick of caoutchouc firmly clasped at the edges in an iron frame. A moveable plate of iron, strengthened by stays, is attached by strong hinges to one of the edges of the tympan frame. This plate, when shut down upon the surface of the tympan, forms the unyielding portion of the press, and supports the engraved plate against the substance intended to be printed, which receives by means of the tympan the pressure produced upon the water at the bottom of the basin.

In order to retain this plate firmly in its place upon the tympan, its edges, as well as those of the basin, should be bevelled in such a manner as to lock the whole way round in a collar with a corresponding groove; this collar opens and closes upon the edges the whole way round by means of two hinges and wide-threaded strong screws, or else by means of a cam or excentric lever lock. A very simple contrivance compels regularity in the proceeding, and prevents accidents, by locking the stop-cock, and preventing the admission of pressure into the basin, until after the plate shall have been shut down and firmly locked upon the tympan.

The engraved plate may either be permanently fastened upon the iron plate, or it may be run into its place in a groove, so as to admit of being easily removed and replaced after each impression, as in the case of copperplate printing.

When it is intended to print paperhangings or cloth with dies, an iron frame instead of the solid plate above described is attached to the hinges; a strong iron axle passing through gudgeons on opposite sides of the frame carries a panel fitting into the frame, and upon this panel the die is fixed. The panel thus revolving completely on the axle at the same time that the frame is raised upon its hinges to a vertical position, admits of the face of the die being alternately brought into contact with the tub, when it is charged with colour, and with the surface of the material intended to be printed.

As to the pressure:—1. The pressure being that of a fluid communicated through a uniformly yielding surface, will be equal at every point. 2. Any amount of pressure can be easily obtained. 3. The amount of pressure can be ascertained with precision, (for instance, by Beurdon's metallic manometer,) and diminished or increased to the exact extent which may be required. 4. Perfectly plane surfaces are no longer the only surfaces capable of being printed. 5. Convex or concave surfaces can thus be printed.

As to the sort of pressure to be used,—steam pressure may be adopted, or the pressure of expanded or condensed air, the hydraulic press, the screw, the cam, or the excentric or knee lever lock. If steam is used, the waste heat will warm the plates in copperplate printing, and will thus get rid of the charcoal dust, so injurious to the health of the workmen.

The expenditure of water or steam may be estimated by considering the surface of the caoutchouc as the surface of a piston, and its depression joined to that of the printed surface as the stroke of the piston; consequently, when the basin is one metre square, there is an expenditure of one litre of air or water for each millimetre in the depression of the surface.

Water appears on the whole the most desirable agent, on account of its non-compressibility and of the small quantity required in order to produce very considerable pressure, as also on account of its non-expansibility, which prevents the possibility of an explosion, for if any breakage takes place the water simply runs out. In experiments which were made with a pressure of from 20 to 30 atmospheres, before perfecting the press, the vessel repeatedly burst, with no greater injury to those engaged than a few splashes.—*Abridged from the Civil Engineer and Architects' Journal.*

NEW FABRICS.

Mr. W. Wilkinson has devised the manufacture of certain new textile and other combined Fabrics, and means of ornamenting fabrics and skins. These fabrics are made by uniting by india-rubber solution, or other adhesive substance, two pieces of cloth, or cloth and silk, or two textile fabrics (ornamented on both sides, or not), and subsequently ornamented or not by embossing or otherwise, and with or without a central strengthening or foundation-piece, or other textile fabric. The inventor also forms a new combined fabric by cementing a cut pile or other fabric to the back of leather, kid, and other skins, and making the solution used to unite the fabric to the skin porous by forming holes therein, that the finished fabric may be porous. He forms elastic stockings and bandages by uniting thicknesses of cotton, silk, or other web by india-rubber solution pierced with holes before being allowed to dry; or he causes a piece of india-rubber cloth pierced with numerous holes to adhere to webs of stocking fabric. The object is to produce elastic stockings and bandages porous throughout. The means of ornamenting fabrics, leather, and skins consist in the application thereon by adhesive matters of patterns and devices produced in similar materials, or in different materials to those upon which the ornament is to be applied, and in the same or different colours. The ornament may be ground flocks, or lace, or flowers produced in silk or cloth to imitate embroidery and otherwise. —*Mechanics' Magazine.*

PRINTING SHAWLS.

Mr. R. A. Brooman has patented certain improvements in apparatus for Printing Shawls and other articles. Here impression-tables and colouring-tables are employed, one or more tables being fixed, and one or more moveable. The moveable tables are each supported upon a horizontal frame or platform which rests upon rollers carried at the extremities of levers. These levers are mounted excentrically upon centres, and have their opposite extremities connected by links to other levers, which are again connected by levers to the end or ends of a beam or beams. When this beam or these beams is or are caused to rock by a hand lever or otherwise, the several links and levers impart an upward or downward motion to the platform or frame, and through it to the table, the motion being rendered smooth and easy by the rollers on which the platform immediately rests. The printing-blocks are supported upon wheels which run on rails, and are successively passed over the colouring-tables and the impression-tables, which are successively forced up to them by the parts before described. Provision is made for fixing the printing surfaces before the shawl, &c., extended upon the impression-table is brought up against it, and also for adjusting the shawl, and bringing the desired portions of it successively beneath the same printing surface. When the colouring-table is fixed, a colour roller is connected to it, and arranged so that it will turn when the printing surface moves over it in one direction, and remain at rest when that surface moves over it in the opposite direction.—*Ibid.*

PREVENTION OF FORGERY.

MR. W. HERAPATH has patented an improvement in the manufacture and treatment of paper with the view to the Prevention of Forgery. This consists in treating paper with a solution of Ferrocyanide, a Ferridcyanide, or a sulphocyanide of potassium, sodium, or ammonium; these salts with the alum used with size produce a tint which may be varied by the addition of small quantities of such metallic salts as will produce the required tint. The colour of common ink written upon paper prepared as above will, upon being exposed to the action of acids of an electro-negative character, be changed from black to blue or red; and with alkalies or electro-positives to a brown red, and render the attempt to extract the ink visible.

TO RECOVER DAMAGED LETTERS.

MR. ALFRED SMEE, of the Bank of England, thus describes a process which he has successfully adopted for restoring the writing of letters damaged by sea-water:—The letter should be lightly once brushed over with diluted muriatic acid, and then brushed over with a saturated solution of yellow ferruginate of potash, when immediately the writing appears in Prussian blue. A piece of *clean* paper, folded up, was found in one of the cairns of which Captain M'Clintock spoke, on his recent return from the Arctic regions. Is it not unlikely that a piece of paper, unwritten upon, should have been folded up and deposited in such a cairn, where no written record was found? May it not have really been written upon, but, owing to some peculiarity, either in the ink, or in the climate or locality, or in both, the writing has become invisible? It is to be hoped the relic was not thrown away, and that it will be submitted to some eminent chemist for his opinion or experiments for the restoration of the possible record.

BARCLAY'S PATENT INDELIBLE PAPER.

THE facility with which ordinary written characters can be expunged from paper by chemical bleaching liquids, acids, and alkalies, has led to the adoption, by bankers, for their cheques and drafts, of papers which present an obstacle to the fraudulent alterations of the amount or intent of these documents. Several instances of this description of forgery have occurred; and in the spring of 1859 a cheque was paid at a branch of the Bank of England, in which both the amount had been altered and the crossing extracted by chemical means.

In 1822 William Robson patented a method of securing bankers' cheques by printing upon their surface vegetable colours equally fugitive with common writing-ink. This method and its extension to the tinting of writing-papers in the pulp has been generally adopted by bankers. Those papers which exhibit the perfection of Robson's principles are limited in practice almost exclusively to certain tints obtained from logwood.

Objections have been raised to this principle of securing cheque papers on the ground that after the requisite amount of writing has been discharged from the paper, it is possible to re-tint the portion of the paper which has been bleached simultaneously with the writing. Efforts have been made to render writing-ink practically indelible on sounder chemical principles.

Mr. William Stone's patent (1851) was a step in this direction, and though fully carried out into practice, and possessing some points of merit, it failed to give the complete security desired.

In June, 1859, Mr. Robert Barclay, of Bucklersbury, patented a process of manufacturing a White Writing-paper, on which writing-ink is stated to be unalterable for fraudulent purposes by any existing chemical process.

It has been examined by Professor Brande, of the Mint; Dr. Miller, of King's College; and Mr. Warrington, of Apothecaries' Hall; who have failed in devising any process by which the security of this paper can be evaded.

Any attempt to discharge the writing produces a permanent dye or stain in the substance of the paper, which neither chemical nor artistic skill will remove, thus necessitating the destruction of the document. Writing placed upon this paper strengthens in intensity when exposed to damp, sea-air, water, or other influences, which, under ordinary circumstances, cause writing-ink to fade and become illegible.

Natural Philosophy.

ON THE CONSERVATION OF FORCE. BY PROFESSOR FARADAY.

THE volume of *Experimental Researches in Chemistry and Physics*, (Vol. iii.) which Dr. Faraday has lately published, contains the following original article on the Conservation of Force:—

"During the year that has passed since the publication of certain views regarding gravitation, &c., I have come to the knowledge of various observations upon them, some adverse, others favourable: these have given me no reason to change my own mode of viewing the subject, but some of them make me think that I have not stated the matter with sufficient precision. The word 'force' is understood by many to mean simply 'the tendency of a body to pass from one place to another,' which is equivalent, I suppose, to the phrase 'mechanical force;' those who so restrain its meaning must have found my argument very obscure. What I mean by the word 'force,' is the *cause* of a physical action; the source or sources of all possible changes amongst the particles or materials of the universe.

"It seems to me that the idea of the conservation of force is absolutely independent of any notion we may form of the nature of force or its varieties, and is as sure and may be as firmly held in the mind, as if we, instead of being very ignorant, understood perfectly every point about the cause of force and the varied effects it can produce. There may be perfectly distinct and separate causes of what are called chemical actions, or electrical actions, or gravitating actions, constituting so many forces; but if the 'conservation of force' is a good and true principle, each of these forces must be subject to it: none can vary in its absolute amount; each must be definite at all times, whether for a particle, or for all the particles in the universe; and the sum also of the three forces must be equally unchangeable. Or, there may be but one cause for these three sets of actions, and in place of three forces we may really have but one, convertible in its manifestations; then the proportions between one set of actions and another, as the chemical and the electrical, may become very variable, so as to be utterly inconsistent with the idea of the conservation of two separate forces (the electrical and the chemical), but perfectly consistent with the conservation of a force, being the common cause of the two or more sets of action.

"It is perfectly true that we cannot always trace a force by its actions, though we admit its conservation. Oxygen and hydrogen may remain mixed for years without showing any signs of chemical activity; they may be made at any given instant to exhibit active results, and then assume a new state, in which again they appear as passive bodies. Now, though we cannot clearly explain what the chemical force is doing, that is to say, what are its effects during the three periods before, at, and after the active combination, and only by very vague assumption can approach to a feeble conception of its respective states, yet we do not suppose the creation of a new portion of force for the active moment of time, or the less believe that the forces belonging to the oxygen and hydrogen exist unchanged in their amount at all these periods, though varying in their results. A part may at the active moment be thrown off as mechanical force, a part as radiant force, a part disposed of we know not how; but believing, by the principle of conservation, that it is not increased or destroyed, our thoughts are directed to search out what at all and every period it is doing, and how it is to be recognised and measured. A problem, founded on the physical truth of nature, *is stated*, and, being stated, is *on the way* to its solution.

"Those who admit the possibility of the common origin of all physical force, and also acknowledge the principle of conservation, apply that principle to the sum total of the force. Though the amount of mechanical force (using habitual language for convenience sake) may remain unchanged and definite in its character for a long time, yet when, as in the collision of two equal inelastic bodies, it appears to be lost, they find it in the form of heat; and whether they admit that heat to be a continual mechanical action (as is most probable), or assume some other idea as that of electricity, or action of a heat-fluid, still they hold to the principle of conservation by admitting that the sum of force, *i.e.*, of the 'cause of action,' is the same whatever character the effects assume. With them the convertibility of heat, electricity, magnetism, chemical action and motion, is a familiar thought; neither can I perceive any reason why they should be led to exclude, *à priori*, the cause of gravitation from association with the cause of these other phenomena respectively. All that they are limited by in their various investigations, whatever directions they may take, is the necessity of making no assumption directly contradictory of the conservation of force applied to the sum of all the forces concerned, and to endeavour to discover the different directions in which the various parts of the total force have been exerted.

"Those who admit separate forces inter-unchangeable, have to show that each of these forces is separately subject to the principle of conservation. If gravitation be such a separate force, and yet its power in the action of two particles be supposed to be diminished fourfold by doubling the distance, surely some new action, having true gravitation character, and that alone, ought to appear, for how else can the totality of the force remain unchanged? To define the force 'as a simple attractive force exerted between any two or all the particles of matter, with a strength varying inversely as the square of the distance,' is not to answer the question; nor does it indicate or even assume what are the other complementary results which occur; or allow the supposition that such are necessary: it is simply, as it appears to me, to *deny* the conservation of force.

"As to the gravitating force, I do not presume to say that I have the least idea of what occurs in two particles when their power of mutually approaching each other is changed by their being placed at different distances; but I have a strong conviction, through the influence on my mind of the doctrine of conservation, that there is a change; and that the phenomena resulting from the change will probably appear some day as the result of careful research. If it be said that "'twere to consider too curiously to consider so,' then I must dissent: to refrain to consider would be to ignore the principle of the conservation of force, and to stop the inquiry which it suggests—whereas to admit the proper logical force of the principle in our hypotheses and considerations, and to permit its guidance in a cautious yet courageous course of investigation, may give us power to enlarge the generalities we already possess in respect of heat, motion, electricity, magnetism, &c., to associate gravity with them, and perhaps enable us to know whether the essential force of gravitation (and other attractions) is internal or external as respects the attracted bodies.

"Returning once more to the definition of the gravitating power as '*a simple attractive force exerted between any two or all the particles or masses of matter at every sensible distance, but with a* STRENGTH VARYING *inversely as the square of the distance*,' I ought perhaps to suppose there are many who accept this as a true and sufficient description of the force, and who therefore, in relation to it, deny the principle of conservation. If both are accepted, and are thought to be consistent with each other, it cannot be difficult to add words which shall make 'varying strength' and 'conservation' agree together. It cannot be said that the definition merely applies to the *effects* of gravitation as far as we know them. So understood, it would form no barrier to progress; for that particles at different distances are urged towards each other with a power varying inversely as the square of the distance is a truth: but the definition has not that meaning; and what I object to is the pretence of knowledge which the definition sets up when it assumes to describe, not the partial effects of the force, but the nature of the force as a whole."

GROWTH OF A CRYSTAL.

MR. NEVIL STORY MASKELYNE, in a paper read by him to the Royal Institution, "On the Insight hitherto obtained into the Nature of the Crystal Molecule by the instrumentality of Light," in conclusion, says:—

In every case the growth of a crystal is an inexplicable thing, so long as we endeavour to trace its cause to powers residing in and confined to the molecules. A crystal, like a plant, is developed in a medium, and as the plant owes the special peculiarities of its individual form, notwithstanding the seemingly perfect freedom of its growth, to special circumstances in the soil, the air, the weather during that growth; and its general similarity to other plants of its kind, to the organic laws that control the conditions of its species; so must the crystal be considered as the result of many co-operating influences, including those of the foreign constituents of the mother liquid, those of temperature and other physical conditions, and involving the principle that the molecules, whether those deposited, or those about to become so, affect or are affected by—and that to considerable distances—the whole of the formed and forming crystal matter.

It would be as useless to expect to explain the growth of a crystal without some such view as this, as to endeavour to account for the growth or outward form of a particular plant by the development of a single leaf. (See the entire paper, which has an unusually large number of preliminary and other details, and occupies nearly twelve pages of the Proceedings of the Royal Institution.

SPECIFIC GRAVITIES.

A NEW method of ascertaining and verifying Specific Gravities has been laid before the Academy of Sciences of Paris, by M. A. Meyer, who says :—"The present methods employed for ascertaining specific gravities are very exact, but complicated. In fact, the whole consists in facilitating the means of measuring exactly the volume of water displaced by any given body of which the specific gravity is to be ascertained. The problem," he says, "may be solved in the following manner :—After having filled a vessel with water, place therein the long leg of a syphon. When the water is quite at rest, plunge the body of which the specific gravity is to be measured into the vessel. The water displaced will escape by the syphon, and being caught in a receiver, will represent exactly the volume of the body immersed." The arrangement is spoken of as peculiarly applicable to the measuring of minerals and other substances which cannot be got into the hydrostatic balance.—*Mechanics' Magazine.*

DYNAMICS OF GASES.

A PAPER has been read to the British Association, "On the Dynamical Theory of Gases," by Professor C. Maxwell. The phenomena of the expansion of gases by heat, and their compression by pressure, have been explained by Joule, Claussens, Herapath, &c., by the theory of their particles being in a state of rapid motion, the velocity depending on the temperature. These particles must not only strike against the sides of the vessel, but against each other, and the calculation of their motions is therefore complicated. The author has established the following results :—1. The velocities of the particles are not uniform, but vary so that they deviate from the mean value by a law well known in the "method of least squares." 2. Two different sets of particles will distribute their velocities, so that their *vires vivæ* will be equal; and this leads to the chemical law, that the equivalents of gases are proportional to their specific gravities. 3. From Professor Stokes's experiments on friction in air, it appears that the distance travelled by a particle between consecutive collisions is about $\frac{1}{447000}$ of an inch, the mean velocity being about 1505 feet per second; and therefore each particle makes 8,077,200,000 collisions per second. 4. The laws of the diffusion of gases, as established by the Master of the Mint, are deduced from this theory, and the absolute rate of diffusion through an opening can be calculated. The author intends to apply his mathematical methods to the explanation on this hypothesis of the propagation of sound, and expects some light on the mysterious question of the absolute number of such particles in a given mass.

TRANSMISSION OF HEAT THROUGH DIFFERENT GASES.

PROFESSOR TYNDALL has read to the Royal Institution a paper on this inquiry, in which, after showing the different quantities of Heat transmitted through Different Gases, he adds :—

Similar differences have also been established in the case of vapours. As representatives of this diverse action, the vapour of ether and of bisulphide of carbon may be taken. For equal volumes, the quantity of heat intercepted by the former is enormously greater than that intercepted by the latter.

To test the influence of *quality*, the following experiment was devised. A powerful lime light was placed at one end of the tube, and the rays from it, concentrated by a convex lens, were sent through the tube, having previously been caused to pass through a thin layer of pure water. The heat of the luminous beam excited a thermo-electric current in the pile at the end of the exhausted tube ; and this current being neutralized by the current of the second pile, coal-gas was admitted. This powerful gas, however, had no sensible effect upon the heat selected from the lime light ; while the same quantity of heat, from an obscure source,* was strongly affected.

The bearing of this experiment upon the action of planetary atmosphere is obvious. The solar heat possesses, in a far higher degree than that of the lime light, the power of crossing an atmosphere ; but, when the heat is absorbed by the planet, it is so changed in quality that the rays emanating from the planet cannot get with the same freedom back into space. Thus the atmosphere admits of the entrance of the solar heat, but checks its exit ; and the result is a tendency to accumulate heat at the surface of the planet.

In the admirable paper of M. Pouillet already referred to, this action is regarded as the cause of the lower atmospheric strata being warmer than the higher ones ; and Mr. Hopkins has shown the possible influence of such atmospheres upon the life of a planet situated at a great distance from the sun. We have hitherto confined our attention to solar heat ; but were the sun abolished, and did stellar heat alone remain, it is possible that an atmosphere which permits advance, and cuts off retreat, might eventually cause such an accumulation of small savings as to render a planet withdrawn entirely from the influence of the sun a warm dwelling-place. But whatever be the fate of the speculation, the experimental fact abides—that gases absorb radiant heat of different qualities in different degrees ; and the action of the atmosphere is merely a particular case of the inquiry in which the speaker was at present engaged.*

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* The *quantity* of heat is measured by the amount of the galvanometric deflection which it produces ; its power of passing through media may be taken as a test of *quality*.

MAGNETIC ACTION OF THE SUN.

MR. BRAYLEY has read at the London Institution a lecture "On the Magnetic Action of the Sun, and its Connexion with the Spots, the Earth's Magnetism and the Polar Lights." The principal object of this lecture was to give an illustrated outline of one great result of the discussion (by Major-General Sabine) of the observations made at the British Colonial Magnetic Observatories; by which, as it has been said, we are "landed in a system of cosmical relations, in which both the sun and the earth, and probably the whole planetary system, are implicated." In the opinion of the Joint Magnetic Committee of the British Association for the Advancement of Science and the Royal Society, expressed in their Report just published by the latter body, that discussion has not merely brought into view, but fully established, the existence of a very extraordinary periodicity in the extent of fluctuation of all the magnetic elements, which connects them directly with the physical constitution of the sun, and with the periodical greater or less prevalence of spots on its surface,—the maxima of the amount of fluctuation corresponding with the maxima of the spots, and these again with those of the exhibitions of the Aurora Borealis, which thus appears also to be subject to the same law of periodicity. The discovery made by General Sabine of a decennial period in all those magnetic influences at the surface of the globe, which, by their dependence on the hours of solar time, led him to recognise the sun as their primary cause—operating, however, in some other manner than by its heat—was explained by reference to the observations of Arago on the diurnal variation of the declination, which were purposely selected by the lecturer, as giving independent evidence on the subject, having been made before the establishment of the British Magnetic Observatories, and because that philosopher was evidently unaware of the existence of the periodicity they demonstrate, in common with the later and different observations in which the decennial period was first recognised by Sabine.

A general view was then taken of the phenomena of the Solar Spots, and of the analogy between them and the revolving storms of our own atmosphere first inferred by Sir John Herschel, and since remarkably confirmed, it was stated, by the observations of the Rev. R. Dawes on the rotation of the spots about their own centres, and those of Mr. Carrington on the currents in which they appear to drift across the sun; and the discovery of a decennial period in their amount and frequency by Schwabe of Dessau, in the observations which he has carried on for the third part of a century, was described by reference to tables comparing the periods of the maxima and the minima of the spots with those of the magnetic fluctuations as made known by Sabine, which were thus shown to be, when complete, corresponding periods of ten years. The enormous activity in certain regions of the sun indicated by the magnitude of the spots, and the rapidity of their motions and changes, it was suggested, was adequate to any conceivable exertion of force upon the earth. In proceeding to the third subject of this law of periodicity, the Polar Lights, after a brief description of their characteristic phenomena, Mr. Brayley stated, that in his opinion the only suggestion of their cause, hitherto enunciated, in the nature of a *vera causa*, had been made by Professor Faraday, and had been amply verified by facts subsequently observed,—a statement now made for the first time. In the Bakerian Lecture, read before the Royal Society in 1832, relating his discovery of terrestrial magneto-electric induction, Mr. Faraday showed that effects similar to those he had obtained by instrumental means, but infinitely greater in force, might be produced by the action of the globe, as a magnet, upon its own mass, in consequence of its diurnal rotation; and, in the sequel, he asked whether the Aurora Borealis and Australis might not be the discharge of electricity, thus urged towards the poles, and endeavouring to return, above the earth, to the equatorial regions; citing, as in accordance with an affirmative reply, the effect of an aurora upon the magnetic needle recorded by Mr. R. W. Fox. He did not pursue the subject; but the hypothesis has been abundantly verified, with respect to the production of terrestrial currents of electricity, in the manner inferred, by the earth's rotation, and the other natural motions of conductors cutting the magnetic curves, by facts which the electric telegraph, land and submarine, has disclosed, and some of which were recited; while all the phenomena of the Polar Lights themselves, especially those which are susceptible of precise measurement and instrumental observation, conspire to verify Faraday's suggestion as to their immediate nature and cause. That they are truly electrical in their nature, an inference rendered so probable by their obvious phenomena, Mr. Brayley considered to be proved by their (electro-magnetic inductive) effects on the magnetic elements: nothing hitherto known having the power of producing such effects but magnetism itself, and electricity, while no phenomena of the former are luminous—there is no magnetic light; and the absence of atmospheric electricity during the display of the aurora, paradoxical as it may seem, is a necessary consequence, the electricity being absorbed, as it were, by its conversion into the correlate magnetism, or in other words, ceasing to be statically manifested while being dynamically exerted.

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* While correcting the proof of this abstract, I learned that Dr. Franz had arrived at the conclusion that an absorption of 3·54 per cent. of the heat passing through a column of air 90 centimetres long takes place; for coloured gases he finds the absorption greater; but all colourless gases he assumes show no marked divergence from the atmosphere.—*Poggendorff's Annalen*, xciv.

Some experimental illustrations of the electrical nature of the Polar Lights were then exhibited, in which the luminous disruptive discharge was taken in exhausted tubes, that is, in excessively rare media resembling in their attenuation the atmosphere itself at the elevations where the Aurora occurs; one of the tubes, prepared by M. Gassiot, showing the stratified discharge (originally obtained by

Mr. Grove), recently cited by Humboldt in evidence that the dark spaces in the Aurora may be real, and not merely the effect of contrast. The source of the electricity in these experiments being the apparatus termed the Ruhmkorff coil, the close accordance between them and the natural phenomenon was pointed out, in the fact that the electricity was obtained by a process of magneto-electric induction, exactly analogous, on the small scale, to the natural process to which, operating in the globe itself, Faraday has referred the electricity manifested in the Polar Lights. The actual influence of the Aurora on the magnetic elements was exemplified by three photographs from the self-registering apparatus at the Kew Observatory, on which the vertical, the horizontal, and the total-force magnetometers, respectively, had recorded the disturbances produced in them by the Aurora of December 3, 1858. The facts establishing the participation of the Polar Lights in the great law of solar periodicity which it had been the object of the lecturer thus generally to explain, were then briefly stated; and the conclusion was deduced, that the relation of the periodicity to the electrical causation of the Polar Lights, is simply this—that the magnetic action of the sun periodically affects the terrestrial magnetism, which, being converted into electricity by the earth's rotation and moving conductors, agreeably to the theory maintained, exhibits the period in the polar discharges of that electricity.—*Athenæum Report.*

ROTATORY MOTION AND ASTRONOMICAL OBSERVATIONS AT SEA.

A PAPER has been read at the United Service Institution, by the Rev. Baden Powell, M.A., F.R.S., Savile Professor of Geometry, Oxford, on "Rotatory Motion, and its application to obtain stability for Astronomical Observations at Sea." The object of the lecture was to explain the principles on which, recently, plans have been proposed and successfully tried, for obtaining a stable platform for an artificial horizon, and a support for a telescope on board ship. The principles of contrivances hitherto adopted were shown to be defective on mechanical grounds, as mere suspension generates pendulum motion. The rotatory principle applied in the "top" of Terson and of Troughton, as the centre of gravity is below, involve the same defect. This defect is obviated by suspending a revolving desk in gymbals accurately balanced on its centre of gravity on the principle of the gyroscope. Such a machine has been constructed and actually used by Professor C. P. Smith, on his voyage to Teneriffe. It affords a support either for his artificial horizon (constructed by means of a spirit level), and when on a larger scale for a telescope, which may be applied to the observation of the eclipse of Jupiter's satellites, so valuable for determining the longitude, but without it incapable of being observed. A working model of the machine was exhibited.

THE MOON'S MOTION.

THE Astronomer Royal has communicated to the British Association a paper, "On the present State and History of the Question respecting the Acceleration of the Moon's Motion." It had been known, from the time of Newton, that the motions of the moon are disturbed by the attraction of the sun, and that a great part of the effect is of the following kind, viz., that when the moon is between the sun and the earth, the sun attracts the moon away from the earth; and when the earth is between the sun and the moon, the sun attracts the earth away from the moon: and thus, in both cases, it tends to separate the earth and the moon, or diminishes the attraction of the moon to the earth. There are sometimes effects of the opposite character; but, on the whole, that just described is predominant. If this diminution were always the same in amount, the periodic time of the moon passing round the earth would always be the same. But it was found in the last century, by Halley and Dunthorne, that the periodic time is not always the same. In order to reconcile the eclipses of the moon recorded by Ptolemy with modern observations of the moon, it was necessary to suppose that in every successive century the moon moves a little quicker than in the preceding century, in a degree which is nearly represented by supposing that at each successive lunation the moon approaches nearer to the earth by *one inch*. The principal cause of this was discovered by Laplace. First, it had been shown by him and by others that the attractions of the other planets on the sun and on the earth do not alter the longer axis of the orbit which the earth describes round the sun, and do not alter the length of the year; but they diminish slowly but continually through many thousands of years the degree of ellipticity of the earth's orbit. Now, when the earth is nearest to the sun, the decrement of attraction of the moon to the earth (mentioned above) is greatest; and when the earth is furthest from the sun, that decrement is least. It had been supposed that the fluctuations of magnitude exactly balance. But Laplace showed that they do not; he showed that the increased amount of decrement (when the earth is nearest the sun) overbalances the diminished amount (when the earth is furthest from the sun); and, therefore, that the less excentric is the earth's orbit, the less does the increased amount of decrement at one part overbalance the diminished amount at another part, and the less is the total amount of the sun's disturbing force. And, as the sun's disturbing force diminishes the moon's attraction to the earth, that attraction is less and less impaired every century, or becomes practically stronger: every century the moon is pulled into a rather smaller orbit, and revolves in a rather shorter period. On computing the effect from this cause, it was found to agree well with the effect which Halley and Dunthorne had found in observations.

The Lunar Tables thus amended (and with other, but minor, improvements) were applied to the computation of other ancient eclipses which require far greater nicety than Ptolemy's lunar eclipses, namely, total eclipses of the sun. The most remarkable of these were the eclipse of Thales (which occurred at a battle), that at Larissa or Nimrúd (which led to the capture of that city by the Persians from the Medes), and that of Agathocles (upon a fleet at sea). They are all of great importance in settling the chronology.

Dates were thus found for these several eclipses which are most satisfactory.

About this time Mr. Adams announced his discovery, that a part of the sun's disturbing force had been omitted by Laplace. The sun pulls the moon in the direction in which she is going (so as to accelerate her) in some parts of her orbit, and in the opposite direction (so as to retard her) in other parts. Laplace and others supposed that these accelerations and retardations exactly balance. Mr. Adams gave reasons for supposing that they do not balance. In this he was subsequently supported by M. Delaunay, a very eminent French mathematician, who, making his calculations in a different way, arrived at the very same figures. But he is opposed by Baron Plana, by the Count de Pontécoulant, and by Professor Hansen, who all maintain that Laplace's investigations are sensibly correct. And in this state the controversy stands at present. It is to be remarked, that observations can here give no assistance. The question is purely whether certain algebraical investigations are right or wrong. And it shows that what is commonly called "mathematical evidence" is not so certain as many persons imagine; and that it ultimately depends on moral evidence. The effect of Mr. Adams's alteration is to diminish Laplace's change of the periodic time by more than one-third part. The computations of the ancient eclipses are very sensibly affected by this. At present we can hardly say how much they are affected; possibly those of Larissa and Agathocles would not be very much disturbed; but it seems possible that the computed eclipse of Thales might be thrown so near to sunset as to be inapplicable to elucidation of the historic account. This is the most perplexing eclipse, because it does not appear that any other eclipse can possibly apply to the same history. The interest of this subject, it thus appears, is not confined to technical astronomy, but extends to other matters of very wide range. And the general question of the theory of the moon's acceleration may properly be indicated as the most important of the subjects of scientific controversy at the present time.

AQUEOUS VAPOUR OF THE ATMOSPHERE.

ADMIRAL FITZROY has read to the British Association a paper, in which, in order to show why this subject was of urgent importance, the author gave a brief description of the origin, nature, and objects of the Meteorological Department of the Board of Trade, which was instituted to collect and publish meteorological observations made at sea; and explained that he now required the opinions of competent authorities as to the best method of publishing a great accumulation of valuable observations. Referring especially to the division of opinions of some scientific men on the question of Aqueous Vapour, and the reduction of barometrical observations, the Admiral quoted passages from the reports of Colonel James and Professor Patten, printed in the third number of *Meteorological Papers*, published by the Board of Trade in 1858. Admiral Fitzroy then submitted to the President of the Section that it would be desirable to elicit some authoritative opinions on the subject in question, before he proceeded to other meteorological perplexities which he had in reserve for another occasion.

The Astronomer Royal expressed his full sense of the importance of this particular question and of the extreme difficulty of dealing with meteorology, not only because of its extent and complication, but because of the want of sufficient facts on which to base sound theory. He approved of Admiral Fitzroy's views generally, but adopted a more rigid adherence to the results of Dalton's and Regnault's experiments, which showed that one gas is a vacuum to another. The Astronomer Royal hoped that Admiral Fitzroy would publish the results (to which reference had been made), in a reduced state, and would show the originals, as well as the elements of reduction likewise.

INTENSIFICATION OF SOUND; THE PHONOSCOPE AND HYDROPHONE.

Dr. Scott Alison has read to the Royal Society a paper, "On the Intensification of Sound through Solid Bodies by the interposition of Water between them and the distal extremities of Hearing-Tubes." The author gives an account of various experiments which he has recently made on sounds proceeding through solid bodies. He has found that sounds which are faint, when heard by a hearing-tube applied directly to solid sounding bodies, become augmented when water is interposed between these bodies and the distal extremity of the hearing-tube. He has been able, by the employment of water, to hear the sound of a solid body, such as a table, which, without this medium, has been inaudible. Experiments have been made upon water in various amounts and in different conditions. Thus a very thin layer, a mere ring round the edge of the hearing-tube, masses of water in larger or smaller vessels, and a bag of water, have been employed. The results have been the same as regards augmentation. The degree of augmentation was greatest when the hearing-tube was immersed freely in water. In experimenting upon water in vessels, it was found necessary to close the extremity of the tube to be immersed, by tying over it a piece of bladder or thin india-rubber; for the entrance of water into the interior interfered greatly with the augmentation.

The effect of water in augmenting sound is materially reduced if even a small amount of solid material be interposed between the water employed and the mouth of the hearing-tube. A piece of wood, not much thicker than a paper-cutter, materially interferes with the augmenting power of water. The augmentation of sound thus obtained by water seems to be due to the complete fitting of the liquid on the solid body, and also round the mouth of the hearing-tube, whereby the column of air is thoroughly enclosed; also to the less impediment to the vibrations of the instrument when held in contact with water, than when held in contact with a solid body, the water yielding in a greater degree than a solid.

The mode of judging of the augmentation was twofold: 1st, one sensation was compared with another perceived by the same ear, the one sensation following immediately upon the other; 2nd, the differential stethophone was employed, by which two impressions are simultaneously made upon the two ears; in which case, if one impression be materially greater than the other, sound is perceived in that ear only on which the greater impression is made. To obtain the advantage of the differential stethophone, or "Phonoscope," as it might here perhaps be more correctly designated, when sounds at some distance from the ear were being examined, its length was increased by the addition of long tubes of india-rubber.

Experiments were made upon other liquids besides water, such as mercury and ether.

Other materials besides liquids were found to afford a similar intensification of sound from solid bodies, such as laminæ of gutta percha, or of india-rubber, and sheets of writing paper, but the amount of augmentation was less.

The hearing-tubes employed were various. Many of the experiments were performed with the author's ordinary differential stethophone, an instrument described in the *Philosophical Magazine* for November, 1858. India-rubber tubes fitted with ivory ear-knobs, and with wooden or glass cups (the size of the cup or object-extremity of ordinary stethoscopes), and having an ear-extremity to pass into the meatus, and brass tubes, were also in turn employed. Tubes closed at their distal extremity with solid material, such as glass, did not answer so well as those closed with membrane.

The water-bag increases the impression conveyed to the ear by the wooden stethoscope, if it be placed between the flat ear-piece and the external ear. It may be employed alone to reinforce sound. The name of *Hydrophone* has been given to it.

A postscript is added, in which the author records an experiment made on the bank of the Serpentine river. A sound produced upon the land was heard at a point in the water when it could not be heard at an equal distance on the ground, if the two limbs of the differential stethophone were employed simultaneously.

The sensation upon the ear, connected, by means of a hollow tube, with water in sonorous undulations, was found to be much greater than that upon the ear connected with the same water by means of a solid rod. When both tube and solid rod were employed simultaneously, sound was heard in that ear only supplied with the tube.

THE PHONAUTOGRAPH.

THERE has been exhibited to the British Association an instrument with the above name, for registering Simple and Compound Sounds, by the Abbé Moigno. The Phonautograph consists of a large chamber or drum, of a spheroidal form, with a diaphragm or drum-head at one end, which, by a system of levers, works the pen which records the sounds which the form of the chamber causes it to concentrate on the tympanum. The Abbé exhibited a drawing which explained the construction of the instrument, and then exhibited drawings showing the actual markings of the pen over a sheet of paper carried past it by clockwork, 1st, when tuning-forks sounding various notes were vibrated in presence of the instrument; 2nd, when several notes were sounded on a diapason pipe; and, 3rd, when a person spoke before it. In the first two cases the recording pen drew such regular curves, that the number of vibrations corresponding to the note as seconds could be counted, and, as the Astronomer Royal observed, they were obviously the curve of sines. In the case of the human voice the words spoken were written below the corresponding tracings of the pen; and although these were very irregular, yet a marked correspondence could be traced, especially where the words contained *r*'s, *g*'s, and other well-marked low or guttural sounds.

THERMOMETRIC STATIONS ON MONT BLANC.

PROFESSOR TYNDALL has communicated to the British Association the following paper. "On the Establishment of Thermometric Stations on Mont Blanc:"—

I proposed to the Royal Society some months ago to establish a series of stations between the top and the bottom of Mont Blanc, and to place suitable thermometers at each of them. The Council of the Society thought it right to place a sum of money at my disposal for the purchase of instruments and the payment of guides; while I agreed to devote a portion of my vacation to the execution of the project. At Chamouni I had a number of wooden piles prepared, each of them shod with iron, to facilitate the driving of it into the snow. The one intended for the summit was 12 feet long and 3 inches square; the others, each 10 feet long, were intended for five stations between the top of the mountain and the bottom of the Glacier de Bossons. Each post was furnished with a small cross-piece, to which a horizontal minimum thermometer might be attached. Six-and-twenty porters were found necessary to carry all our apparatus to the Grands Mulets, whence fourteen of them were immediately sent back. The other twelve, with one exception, reached the summit, whence six of them were sent back. Six therefore remained. In addition to these we had three guides, Auguste Balmat being the principal one; these, with my friend Dr. Frankland and myself, made up eleven persons in all. Though the main object of the expedition was to plant the posts and fix the thermometers, I was very anxious to make some observations on the diathermancy of the lower strata of the atmosphere. I therefore arranged a series of observations with the Abbé Veullet, of Chamouni; he was to operate at Chamouni, while I oberved at the summit. Our instruments were of the same kind; and in this way we hoped to determine the influence of the stratum of air interposed between the top and bottom of the mountain upon the solar radiation. Wishing to commence the observations at an early hour in the morning, I had a tent carried to the summit. It was ten feet in diameter, and into it the whole eleven of us were packed. The north wind blew rather fiercely over the summit; but we dropped down a few yards to leeward, and thus found shelter. Throughout the night we did not suffer at all from cold, though the adjacent snow was 15° Centigrade, or 27° Fahr. below the freezing point of water. We were all, however, indisposed. I was, indeed, unwell when I quitted Chamouni; but I fully expected to be able to cast this off during the ascent. In this, however, I was unsuccessful; my indisposition augmented during the entire period of the ascent. The wind increased in force towards morning; and as the fine snow was perfectly dry, it was driven upon us in clouds. Had no other obstacle existed, this alone would have been sufficient to render the observations on solar radiation impossible. We were therefore obliged to limit ourselves to the principal object of the expedition—the erection of the post for the thermometers. It was sunk six feet in the snow, while the remaining six feet were exposed to the air. A minimum thermometer was screwed firmly on to the cross-piece of the pile; a maximum thermometer was screwed on beneath this, and under this again a wet and dry bulb thermometer. Two minimum thermometers were also placed in the snow; one at a depth of six, and the other at a depth of four feet below the surface; these being intended to give us some information as to the depth to which the winter cold penetrates. At each of the other stations we placed a minimum thermometer in the ice or snow, and a maximum and a minimum in the air. The stations were as follow:—

The summit, Corridor, Grand Plateau, the glacier near the Grands Mulets, and two additional ones between the Grands Mulets and the end of the Glacier de Bossons. We took up some rockets, to see whether the ascensional power or the combustion was affected by the rarity of the air. During the night, however, we were enveloped in a dense mist, which defeated our purpose. One rocket, however, was sent up, which appeared to penetrate the mist, and rising probably above it, its sparks were seen at Chamouni. Dr. Frankland was also kind enough to undertake some experiments on combustion: six candles were chosen at Chamouni, and carefully weighed. All of them were permitted to burn for one hour at the top; and were again weighed when we returned to Chamouni. They were afterwards permitted to burn an hour below. Rejecting one candle, which gave a somewhat anomalous result, we found, to our surprise, that the quantity consumed at the top was, within the limits of error, the same as that consumed at the bottom. This result surprised us all the more, inasmuch as the *light* of the candles appeared to be much feebler at the top than at the bottom of the mountain. The explosion of a pistol was sensibly weaker at the top than at a low level. The *shortness* of the sound was remarkable; but it bore no resemblance to the sound of a cracker, to which, in acoustic treatises, it is usually compared. It resembled more the sound produced by the explosion of a cork from a champagne-bottle, but it was much louder. The sunrise from the summit exceeded in magnificence anything that I had previously seen. The snows on one side of the mountain were of a pure light blue, being illuminated by the *reflected* light of the sky; the summit and the sunward face of the mountain, on the contrary, were red from the *transmitted* light, and the contrast of both was finer than I can describe. I may add, in conclusion, that the lowest temperature at the summit of the Jardin during last winter was 21° Cent. below zero. We vainly endeavoured to find a thermometer which had been placed upon the summit of Mont Blanc last year.

PHOSPHORESCENCE AND FLUORESCENCE.

PROFESSOR FARADAY has read to the Royal Institution a paper upon the great advance in the experimental part of this subject which has recently been made by E. Becquerel. Mr. Faraday having illustrated the effect of Phosphorescence, and the phenomena of Fluorescence, showed that many phosphori are highly fluorescent. Thus, if one of them be exposed to the strong voltaic light, and then placed in the dark, it is seen to be brilliantly luminous, gradually sinking in brightness, and ultimately fading away altogether; but if it be held in the rays beyond the violet end of the spectrum, (the more luminous rays being shut off,) it is again seen to be beautifully luminous, but that state disappears the instant it is removed from the ray. Now, this is fluorescence, the same body seeming to be both phosphorescent and fluorescent. Considering this matter, and all the circumstances regarding time, Becquerel was led to believe that these two luminous conditions differed essentially only in the *time* during which the state excited by the exposure to light continues; that a body being really phosphorescent, but whose state falls instantly, is fluorescent, giving out its light while the exciting ray continues to fall on it, and during that time only; and that a phosphorescent is only a more sluggish body which continues to shine after the exciting ray is withdrawn. To investigate this point he invented the *Phosphoroscope*, an apparatus in which disc, or other surfaces illuminated by the sun or an electric lamp, may, by revolution, be rapidly placed before the eye in a dark chamber, and so regarded in the shortest possible space of time after their illumination. By such an apparatus, Becquerel has shown that all the fluorescent bodies are really phosphorescent; but that the emission of light endures only for a short time.

Professor Faraday then made an extensive series of experimental illustrations upon the foregoing points, employing fine specimens of phosphori, for which he was indebted to Mr. Becquerel himself. The phosphoroscope employed consisted of a cylinder of wood, one inch in diameter and seven inches long, placed in the angle of a black box with the electric lamp inside, so that three-fourths of the cylinder were external, and in the dark chamber where the audience sat, and one-fourth was within the box, and in the full power of the voltaic light. By proper mechanical arrangements this cylinder could be revolved, and the part which was at one instant within, rapidly brought to the outside, and observed by the audience. As the cylinder could be made to revolve 300 times in a second, and as the twentieth part of a revolution was enough to bring a sufficient portion of the cylinder to the outside, it is evident that a phosphorescent effect which would last only the 1-3000th or even the 1-6000th of a second might be made apparent. All escape of light between the moving cylinder and the box was prevented by the use of properly attached black velvet.

The cylinder was first supplied with a surface of Becquerel's phosphori. The effect here was, that when by rotation the part illuminated was brought outside the box it was found phosphorescent. If the cylinder continued to rotate it appeared equally luminous all over, and when the rotation ceased, or the lamp was extinguished, the light gradually sank as the phosphorescence fell. Then a cylinder having a surface of quinine or æsculin was put into the apparatus. Whilst the cylinder was still it was dark outside; but when revolving with moderate velocity it became luminous outside, ceasing to be so the moment the revolution stopped. Here the fluorescence was evidently shown to occupy time; indeed, the full time of a revolution: and taking advantage of that, the self-shining of the body was separated from its illumination within, and the fluorescence made to assume the character of phosphorescence. Another cylinder was covered with crystals of nitrate of uranium, a hot saturated solution having been applied over it with a fine brush. The result was beautiful. A moderate degree of revolution brought no light out of the box; but with increased motion it began to appear at the edge. As the rapidity became greater, the light spread over the cylinder, but it could not be carried over the whole of its surface. It issued as a band of light where the moving cylinder left the edge of the box, diminishing in intensity as it went on, and looking like a bright flame, wrapping round half the cylinder. When the direction of revolution was reversed, this flame issued from the other side; and when the motion of the cylinder was stopped, all the phenomena of fluorescence or phosphorescence disappeared at once. The wonderfully rapid manner in which the nitrate of uranium received the action of the light within the box, and threw off its phosphorescence outside, was beautifully shown.

The electric light, even when the discharge is in rarefied media, or as a feeble brush, emits a great abundance of those rays which produce the phenomena of fluorescence; but then if these rays have to pass through common glass they are cut off, being absorbed and destroyed even when they are not expended in producing fluorescence or phosphorescence. Arrangements can however be made in which the advantageous circumstances can be turned to good account with such bodies as Becquerel's phosphori or uranium glass. If these be enclosed within glass tubes, having platinum wires at the extremities, and which are also exhausted of air and hermetically sealed, then the discharges of a Ruhmkorff coil can be continually sent over the phosphori, and the effects both fluorescent and phosphorescent be beautifully shown. The first or immediate light of the body is often of one colour, whilst on the cessation of the discharge the second or deferred light is of another; and many variations of the effects can be produced.

In connexion with rarefied media it may be remarked, that some of the tubes by Geissler and others have been observed to have their rarefied atmospheres phosphorescent, glowing with light for a moment or two after the discharge through them was suspended. Since then Becquerel has observed that oxygen is rendered phosphorescent, *i.e.*, that it presents a persistent effect of light, when electric discharges are passed through it. Mr. Faraday has several times had occasion to observe that a flash of lightning, when seen as a linear discharge, left the luminous trace of its form on the clouds, enduring for a sensible time after the lightning was gone. He strictly verified this fact in June, 1857, recording it in the *Philosophical Magazine*, and referred it to the phosphorescence of the cloud. He has no doubt that that is the true explanation.

INFLUENCE OF LIGHT ON THE GROWTH AND NUTRITION OF ANIMALS.

Dr. Gladstone, in a paper read by him to the Royal Society, gives, as the result of his experiments on this subject, under the head of colour, what he considers a new construction upon the facts observed by Professor Forbes. He discovered that increased depth of sea corresponds with diminished light, and that both of these conditions again correspond with peculiar changes in colour, and ultimately with loss of colour in the shells inhabiting these depths; but there is no evidence to show that these colourless shells have developed any materials capable of manifesting colour after exposure to the influence of light; whereas my own and other experiments show that the *etiolated* stalks and leaves of plants speedily manifest the characteristic colour of the chlorophyl if placed in the sun's rays.

So far, therefore, as our present knowledge on the subject justifies any conclusion, the varieties of colour and the absence of colour in the mollusks are physiologically separated from the phenomena of etiolation of plants, and may be placed in the same category as the varieties of colour and the absence of colour in the corollas of flowers, which depend upon the development of materials having certain optical properties.

The beautiful facts observed by Professor Forbes, instead of being regarded as the consequence of imperfect exposure to light, must, Dr. Gladstone thinks, take rank with the phenomena of colouration observed throughout the animal kingdom, such as the peculiar markings of reptiles, birds, and wild animals, according to their different habitats and modes of life; the colours of the upper and lower surfaces of fish, and the like; which cannot be shown to depend upon the exposure or non-exposure to light with which they frequently, but not always, coincide. These facts appear only to form a part of the vast and perfect plan of creation, in which everything that exists is suited in every particular to the conditions of its existence; thus, those mollusks which are designed to inhabit depths scarcely permeable to light, can have no need, and hence have no provision, for elements, to the manifestation of which light is an essential condition.

COLOUR-BLINDNESS.

Professor G. Wilson, M.D., has communicated to the British Society some statistics on this term. Colour-blindness is applied not to a disease of vision, but rather a remarkable type of vision. Dr. Wilson went on to give an explanation of the nature of this visual peculiarity, illustrating his remarks by laughable instances. "Colour-blind people," he said, "don't see the red in pink—they think it is white; and if we darken red with black, they stop seeing any red in it, and call it black before we do." This peculiarity, however, shows itself chiefly—first, in the confounding of red and green,—secondly, in matching or confounding dark red and brown,—thirdly, in confounding red and black,—and, lastly, in confounding different shades of the same colour. As examples of this peculiarity, the Professor mentioned the case of an upholsterer, in Edinburgh, who covered a coffin with scarlet cloth; and of a gentleman who asked a lady with a red velvet bonnet for whom she was in mourning. The earliest case of colour-blindness on record was mentioned in an old number of the *Philosophical Transactions*. A wedding was about to take place, and the father of the bride was about to send the bridegroom home for coming in a black dress. The bride remonstrated with her father, and assured him that it was not a black dress, but what she thought a genteel colour—claret. As regards red and green, colour-blindness in this respect is generally discovered with flowers. Dalton discovered his colour-blindness by hearing parties call a geranium red, which he had thought light blue. Dugald Stewart could not tell a cherry from its leaves—except by the form.

THE KALEIDOSCOPIC COLOUR-TOP.

THE Kaleidoscopic Colour-Top, invented by Mr. John Gorham, is one of those ingenious instruments which combine with entertainment the means of sound instruction. It is calculated to produce good results as regards the combination and contrast of colours, and will, we have no doubt, be largely purchased; for, while it will amuse and please the children, it will also gratify and enlighten their elders, properly looked at. It is curious to notice that, though the several colours are by rapid rotation blended into a compound colour, yet each is restored in its individuality when seen through a perforated black plane, placed at will about an inch above the combined colours, which plane is made, by a simple and very ingenious contrivance, to revolve at a lower rate of speed. It is important to note that, while the results of the mixture of colours by the ordinary process and by rotation bear a striking resemblance, there is a curious exception with respect to the formation of green. Yellow and blue, mixed in any proportions, will produce it, but no yellow and blue rotated will form a green of any sort.

We can see in the kaleidoscopic colour-top a means of teaching many of the most interesting phenomena of colour, and we would suggest that one of the card discs should have the three primary colours *only* painted on it in the proper proportions, so as to show the formation of *white*, which occurs on rapid rotation. The top will serve to elucidate the principles of contrast and the action of the complementary colours. A little girl standing by asks us, "What is meant by complementary colours?" The three primary colours are yellow, red, and blue: what is wanting in a given colour to complete this triad is called its complementary. For example, the complementary of red is yellow and blue (or green); the complementary of blue is red and yellow (or orange); the complementary of yellow is red and blue (or violet). If you look on a colour for a minute or so, and then direct the eye to a contiguous grey surface, the complementary becomes visible. Of course the combinations permitted by the top are infinite; but, as a few examples of elegant effects, we may notice the following:—Blue disc and yellow heart; black disc, yellow heart and multangular blue piece; red disc, green heart and open ring of black; red disc, white multangle and black ring; green disc and red heart; yellow disc and blue heart; the party-coloured discs alone; each combination having a perforated plane dropped down over it, while rotating. Some combinations are, however, very fine without the plane.—*Builder*, No. 845.

CAUSE OF COLOURS.

MR. J. SMITH has exhibited to the British Association two little instruments, fitted to produce rapid whirling motion; by placing in these cards a pure white, so cut out as to give at several distances from the centre various proportions of the white parts remaining, and placing the instrument on an intensely black ground (a piece of black velvet), he succeeded in producing vivid impressions on the eye of several colours, viz., bright reds, dusky reds and browns, deep greens, light greens, yellows of various degrees of purity, orange violets, and other colours; and asserted that, by apportioning the spaces which alternately produced in rapid succession impressions of light and of darkness, he could at pleasure cause any colour he desired to be seen while the rapid motion was continued.

DECOMPOSITION OF ANCIENT GLASS.

SIR DAVID BREWSTER has read to the British Association a paper "On the Decomposed Glass found at Nineveh and other Places." Sir David described the general appearance of glass in an extreme state of decomposition, when the decomposed part was so rotten as to break easily between the fingers, a piece of undecomposed glass being generally found in the middle of the plate. He then explained how, in other specimens, the decomposition took place around one, two, or more points, forming hemispherical cups, which exhibit the black cross and the tints of polarized light. In illustration of this decomposition, he showed to the meeting three specimens, in one of which there was no colour, but which consisted of innumerable circular cavities with the black cross, these cavities giving it the appearance of ground-glass. In another specimen the film was specular and of great beauty, showing the complementary colours by reflection of transmitted light. In a third variety the films were filled with circular cavities exhibiting the most beautiful colours, both in common and polarized light. Various other remarkable properties of these films were described by the author.

ACHROMATIC LENS.

MR. A. CLAUDET has described to the British Association his "Changing Diaphragm for Double Achromatic Combinations," a contrivance intended to reduce or increase the aperture of a double achromatic lens without having to unscrew one of the lenses and without any slit on the tube. This is done by two rings revolving on one another, like the top and bottom part of a snuff-box, and each carrying a number of india-rubber stripes, the other end of which was fixed on the opposite ring, so that making the ring not fixed in the tube to revolve by an external pinion, the india-rubber stripes were drawn intermixing each other until each of them was extending on the diameter of the tube, on which disposition the whole aperture was shut. Mr. Claudet exhibited also the very ingenious pupil diaphragm, invented by Mr. Mauley, optician in Paris.

FOCUS OF OBJECT-GLASSES.

Mr. A. Claudet has explained to the British Association his researches on this question tending to show the relation between the distances and sizes of objects with the focal distances and sizes of their images, and to find the two points, one before the lens and the other behind, from which the distance of objects and the focal distances must be measured, and from which all proportions are in an exact ratio, for it is found that measuring from the object-glass on both sides, double distance of object does not produce one-half of the focal distance, and *vice versâ.* These two points are, first, the point before the lens which produces an image infinitely larger at infinite distance, and behind the lens the point which is the focus for an object at infinite distance, giving an image infinitely small; it is obvious that these two points are on each side the zero of the scale of measure, and it remained to fix the position of another point before the lens, which produces behind the lens an image as large as nature. The two spaces between these two points, one in front and the other behind the lens, are perfectly equal, and they are each the unit by which all distances of objects and all focal distances are to be measured. Double the unit in front will give a focus one-half of the unit behind the lens, and one-half of the unit in front will give a focal distance double of the unit behind the lens, and all the other distances in the same proportion, so that knowing either the distance in front of the lens, or the focal distance, the other distance can be found without having to examine the focus on the ground-glass; the only thing to do being to divide the scale called "the unit of focal distances," in any number of parts corresponding in an inverted ratio with the progression of distances in front of the glass. The paper contained many other very important and new investigations on that interesting question of optics, into which we cannot enter in our limited space.—*Athenæum*, No. 1665.

DOUBLE REFRACTION.

Sir David Brewster has exhibited to the British Association a number of beautiful double slips of glass, with small pieces of decomposed glass, which he had obtained from the Marquis Campana in Rome, interposed, which showed all the various tints of Newton's thin plates. Sir David then explained how, by the polarization in two different places of the transmitted light and the interference of those which were retarded by internal reflection at the surfaces of these very thin films, none of them the two-thousandth of an inch thick, the varied tints were produced. He also explained minutely their optical properties when examined by the polariscope.

The Rev. Dr. Lloyd could not agree with Sir David Brewster that this was a new species of double refraction, but explained how it was to be viewed as an instance of interference of the two beams of light polarized in opposite planes. Professor Forbes drew the attention of the Section to the similarity of the properties of these films to those he had many years exhibited to the Section, which he had obtained by heating plates of mica, and which he had used in his experiments on polarized heat.

LANDSCAPE IN CALCEDONY.

Sir David Brewster has exhibited to the British Association a curious Landscape enclosed in a specimen of Calcedony, belonging to a lady. Sir D. Brewster, who had examined the specimen, ascertained that the landscape was not between two plates subsequently united, but was in the interior of a solid piece of calcedony. He stated that calcedony was porous, and that the landscape was drawn by a solution of nitrate of silver, which entered the pores of the mineral. Sir David also stated that above thirty years ago he had examined a similar specimen, belonging to the late Mr. Gilbert Innes, of Stow, who had paid a large price for it. Having no doubt that the figure of a cock which it contained was drawn by nitrate of silver, introduced into the pores of the mineral, he induced the late Mr. Somerville, a lapidary in Edinburgh, to make the experiment, and he succeeded in introducing the figure of a dog into the interior of the mineral. "The curious fact, however, displayed by the specimen now exhibited to the Section is, that the landscape had entirely disappeared after being kept four years in the dark. When I received the specimen yesterday from Miss Campbell, the landscape was wholly obliterated; but after the exposure of an hour this morning, it re-appeared in the distinctest manner, as may be seen by looking at it against a white ground." It is of importance to remark, that the figure of the cock in Mr. Innes's specimen, which was very strong in its tint, has never been seen either to disappear or to diminish in its tints.

ANALYSIS OF LIGHT.

M. Porro has submitted to the British Association a Portable Apparatus for Analysing Light, invented by him. This instrument was a telescope, at the side of which the light to be analysed could be introduced by a slit, and being then reflected down, met a prism of flint glass, with its remote side silvered, and placed perpendicularly to the axis of the observing or telescopic part, the light then reflected back is dispersed as if by a prism of double the refracting angle of the prism of the instrument, and the dispersion then measured by a micrometer placed at the focus of the eye-piece.

SUGGESTION FOR FOG-SIGNALS.

Sir David Brewster, in a note to *Comptes Rendus*, Feb. 21, 1859, says:—"While I was investigating the polarization of the atmosphere, I observed the remarkable fact, that when objects situated far off in the open country are rendered indistinct by the interposition of a light mist, a part of their distinctness may be restored by viewing them through a Nicol's prism, which extinguishes all the light polarized by the mist in a plane passing through the sun, the object, and the eye of the observer. The objects thus rendered more distinct and visible were seen through that portion of the mist in which the polarization of the light reflected by them was at its maximum. This method of rendering visible objects rendered indistinct by fogs or mists may, it appears to me, receive important applications in military and naval operations."

LUMINOUS IMPRESSIONS ON THE EYE.

PROFESSOR SWAN, in 1849, described to the Royal Society of Edinburgh, a method of observation by which he had succeeded in measuring the brightness of visual impressions of short duration. This consisted in causing a disc with a sector of a known angle cut in it, to revolve with a known uniform velocity between the eye and a luminous object. At each revolution of the disc, a flash is seen. The time during which the light has acted on the eye is easily computed from the angle of the sector and velocity of the disc; and the brightness of the flash is ascertained by photometric arrangements. By this method the brightness of impressions formed on the eye by light acting for short intervals of time varying from ·1 to ·001 of a second was ascertained with results which have been described in the paper already referred to.

It seemed desirable to extend the observations to impressions formed on the eye in intervals of time still shorter than ·001 of a second; and it may seem that this could be accomplished, either by diminishing the angle of the sector, or by increasing the diameter or velocity of rotation of the disc. There are obviously, however, limits to the narrowness of the sector, and to the diameter of such discs as can be used conveniently; and the velocity with which the discs may be driven is also limited, for when the number of revolutions exceeds about ten in a second, the successive impressions, which it is proposed to observe separately, become blended into a single nearly uniform impression, owing to their persistence on the retina. The instrument now described to the Society is devised for the purpose of separating a *single* impression out of the multitude of impressions made by a rapidly revolving disc, so as to render it possible to observe the brightness of isolated visual impressions formed by light acting on the eye for extremely short intervals of time.

The instrument consists of a train of wheels and pinions by which a disc having a sector cut in it is driven with great velocity. The numbers of teeth in the wheels and pinions are so arranged that each wheel, as well as the disc, makes ten revolutions for one revolution of the wheel by which it is driven. Each of the two last wheels of the train, which are of solid metal, has a hole pierced in it, through which light transmitted by the sector can pass to the eye; and the wheels are so placed that at each hundredth revolution of the sector, and only then, the sector in the disc and the holes in the wheels come into the same straight line, so that the eye of the observer receives a single flash transmitted through the holes in the wheels. The result of this arrangement is, that although the disc be driven at the rate of a hundred revolutions per second, so that the impressions produced by the successive flashes transmitted by it when seen by the unassisted eye would be blended into an uniform impression, yet the observer, looking through the holes in the wheels, receives only a single flash of light once a second. The brightness of the observed isolated flashes may be ascertained by photometrical means, similar to those employed by the author for the same purpose in 1849, and which he has fully described.

An Instrument for producing Isolated Luminous Impressions of extremely short duration, varying from one-tenth to one-millionth of a second, was shown. —*Edinburgh New Philosophical Journal*, No. 19.

COMPASSES IN IRON SHIPS.

THERE has been read to the British Association, a "Report on Changes of Deviation of the Compass on Board Iron Ships by 'Heeling,' with Experiments on Board the *City of Baltimore, Aphrodite, Simla*, and *Sleeve Donard*," by Mr. John T. Towson. The author explained the manner in which the Compass Committee was first formed, in accordance with the advice of the Section he was then addressing, and that two reports had been drawn up, which, with the advice of the Astronomer Royal, had been printed and "presented to both Houses of Parliament by command of Her Majesty." He thanked the Astronomer Royal for his valuable advice and support. There were matters of consideration which the Compass Committee deemed incomplete; the one was the change which took place in iron ships in proceeding to the opposite hemisphere; the other, the change that was produced by what is technically denominated *heeling*, that is, when the deck of a vessel leaned over through the action of the wind or otherwise; if when looking towards the bow it slanted downwards to the right it is said to heel starboard, if to the left, to heel port. The first question was undertaken by the late respected Rev. Dr. Scoresby, who proceeded to Australia in the *Royal Charter*, and whose exertions in the pursuit of this branch of the inquiry shortened a most valuable life. The second question was the subject of his (Mr. Towson's) present report. Having described the principles on which his graphic illustration was constructed, he pointed out the unexpected amount of deviation which this source of disturbance (heeling) brought about, amounting in most instances, when the ship's head was in the position to produce the maximum effect, to two or three points in the standard compass, and after to a greater amount as far as the steering compass is concerned. He remarked on several particulars connected with this investigation. Generally the north end of the compass was drawn to the upper side of the ship—the case with seven out of nine compasses on board the *City of Baltimore*, but in the two steering compasses the needles were drawn contrariwise.

Mr. Towson then explained the theory on which this disturbance arose, partly from subpolar magnetism below the compass, and partly from the disturbance of the inductive magnetism of the ships. In such ships as those under consideration, the following empirical rule held good with respect to compasses favourably placed. When the vertical force as determined either by vibrating experiments or torsion on board the ship, maintained the ratio, as compared with the vertical force on shore, in the proportion of nine to fourteen, little or no effect was produced by heeling; and in the case of the *Simla*, this plan of predicting the amount of error was adopted: a moveable upright magnet was applied so as to produce the before-named vertical force, when it was found "with magnet in" no error was produced, although "with magnet out" it amounted to 24° from changing a heel of 10° starboard to 10° port. Another remarkable result appears to exist. He believed that when a ship was built with her head south-east or south-west, little if any effect would be produced by heeling. When examining the magnetic condition of the *Sleeve Donard*, they were surprised to find that the vertical was very nearly that which would give no effect from heeling. Their talented stipendiary Secretary (to whom is due the credit of drawing up the two reports already published) immediately suggested that her head could not have been east when building, which we had taken for granted; and on inquiry we found that on account of her great length she had been built diagonally, with her head south-east nearly. Although Mr. Towson believed that for practical purposes sufficient information had been obtained, yet there were anomalies in their observations that rendered the theories deduced unsatisfactory. This he believed arose from the rapidity with which they were obliged to carry on their experiments, on account of the passing in and out of ships through the docks, from which cause the inductive influence of the earth had not sufficient time to complete its effect. It had been proposed to request the aid of the Admiralty in allowing the Committee to experiment on one of Her Majesty's iron ships in some convenient place for an unlimited time. In conclusion, he requested that the Astronomer Royal would favour the Society with his remarks.

The President remarked, that he himself had made some observations on the deviation of the compass on board an iron ship which he possessed. After trying magnetic compensation, the magnets were taken away, and a table of errors adopted. He believed that magnetic compensation rendered the compass sluggish.

The Astronomer Royal, in reply to the noble President, stated that magnetic adjustment rendered the directive force exercised on the needle equal with the ship's head on all points of the compass. Without compensation, with the ship's head on some point, the directive force was frequently neutralized by the ship's magnetic force. He complimented the Compass Committee for their labours, and the judgment exercised in carrying out their experiments, and he especially referred to the services of Messrs. Rundell and Towson; the former was now carrying out these experiments on board the *Great Eastern*. He had been prepared to find that the compasses on board iron ships were affected by heeling, but was surprised at the amount, yet convinced of the practicability of compensating this source of error. He considered that the Compass Committee should not conclude their labours without further experiments, and thought that the Admiralty should place an iron ship at their disposal.

Admiral Fitzroy bore testimony to the value of the services of the Astronomer Royal. Notwithstanding his great exertions in the pursuit of science in various departments, he believed his great work was his labours in connexion with iron ships.

Professor W. Thomson wished, so far as his opinion could have any weight, to recommend that the necessity for constant determinations of the error of the compass should be enforced on masters of ships generally, but most strongly on all masters of iron ships. It appeared to him that the only way to use the compass safely *is* *never to trust to it*, that is to say, to take azimuths astronomically as often as weather permits, and only to use the compass as a convenience for steering by, according to these azimuths, and as a means of keeping as nearly as possible the desired course in the intervals between the azimuthal determinations. When these intervals amount, as they often do, to several days or weeks, no confidence ought to be felt in the dead reckoning within a wide margin of possible error in the course, and the established precautions on approaching those ought to include a large allowance for this uncertainty. No such security can possibly be had for the determination of direction by the compass as the comparison of two or three or more chronometers always gives in a well-approved ship for determining absolute time.

Professor Thomson referred to the sound and thorough mathematical theory which had been given by Mr. Archibald Smith, and the thoroughly practical manner in which he had applied it, and brought it into form for practical use, in the real circumstances of sea-going ships, by which Professor Thomson believes much has been done to give security to modern navigation. Professor Thomson referred to the case of the wreck of the *Tayleur*, which the late Dr. Scoresby, whose loss was so much felt by this Section, had attributed to a change of the magnetism of the ship (a new iron ship), produced in consequence of being tossed about in the Channel in a gale within a few hours after leaving Liverpool; and remarked that it appeared strongly to corroborate the opinion now expressed by the Astronomer Royal, that new iron ships are liable to sudden and great changes of magnetism on being knocked about in rough weather at sea.

Mr. Towson considered that iron ships were as safe as wooden ships, and remarked that they were insured at the same premium as class A 1 at Lloyd's, which would not be the case if they incurred more risk. He believed when the evils of the compass were got over, they would be by far the safer class of ships.

Admiral Fitzroy writes to the *Athenæum*, No. 1673, as follows:—While the subject of "Compasses in Iron Ships" is before your readers, pray allow me to ask, on behalf of seamen, that mathematicians will add to their invaluable information already spontaneously given (without which a "rule of thumb" would have been the only one) distinct directions for correcting the error caused by *List-deviation.* I use this term in preference to Captain Walker's, namely, "incline-deviation," because "list" is a nautical term, and incline is too near inclination (already inconveniently used for dip). Ships are now "swung" when upright. Their compasses are "adjusted" similarly. But at sea sailing-ships heel, or have a list of, from (say) five to fifteen degrees, and while so listed their deviation is different—sometimes *very* different from that which they would have if upright, with the ship's head in the *same* direction. In one iron-ship—the *W. S. Lindsay*—more than two points of difference were caused by her heeling over under sail (see *Walker on Ships' Magnetism*). The reasons are obvious. When a ship is on "an even keel" (upright) the iron of either side acts on the compass similarly to that of the other. When there is a considerable list, the iron on either side acts differently from that of the other. Captain Walker found, years ago, that tanks and ballast affected the compass differently from guns, shot, and iron in the upper part of the ship; also, that the sharp iron after-bodies or "runs" of vessels (being vertical and very magnetic) have an effect on the compass contrary to that of the iron in the *upper* body of the ship before the binnacles.

A remedy seems to be to place a ship along her *neutral* line (that in which she has the least deviation), then to list or heel her over, as if under sail, and ascertain what difference is caused in the deviation. It appears probable, but it has not been tried, much less proved, that equal or proportionate differences would be caused by equal lists with the ship's head in other directions; but experiments are wanting, and a mathematical head is indispensable, to direct, analyse, and digest them, for the benefit of this iron-ship building country.

DEEP-SEA SOUNDINGS—THEIR UNCERTAINTY.

PROFESSOR W. R. TROWBRIDGE, in a paper in *Silliman's Journal* for November, 1858, observes :—

Prominent among the instances of reported unfathomable depths, stands the sounding of Captain Denham of the British Navy, in H.M.S. *Herald*, made in October, 1852, on a voyage from Rio de Janeiro to the Cape of Good Hope. This is an extreme case ; but since it is reported among the greatest deep-sea casts, it will serve best for illustration. *All other great casts of the lead which have been reported are subject to the same causes of error* which are to be found in this, some in a greater and some in a less degree ; so that it is not necessary for us to believe yet anything with regard to them, except that they gave no result. The sounding of Captain Denham was made with a lead weighing nine pounds, attached to a line one-tenth of an inch in diameter ; and it is reported that this lead descended to the depth of nearly nine miles in the sea without touching bottom.

In accordance with a plan which originated with the lamented G. M. Bache, United States Navy, in 1846, in the explorations of the Gulf-stream, and which has constantly been followed since, Captain Denham noted the time of running out of the successive portions of the sounding-line during the nine hours of its supposed descent. According to these observed times of descent, the nine-pound lead communicated to the descending line at the depth of 3000 fathoms, or 18,000 feet, a velocity of *two feet* per second ; a result which is *philosophically impossible*, since the resistance of the water acting upon a line of this diameter, moving with a velocity of two feet per second, at the depth mentioned, amounts to more than three times the weight of the lead or shot used. It will hardly be necessary to enter into any argument to show that there can be no motion of descent when the resistance to that motion is three times the weight of the moving mass. Further, the observations show that the nine-pound shot and line were running with a velocity of two feet and a half per second at the depth of 2000 fathoms, or 12,000 feet. Here the result contradicts in quite as strong a manner the mechanical laws of the descent; and in fact below 1000 fathoms, or 6000 feet, if we credit the observations, a velocity was observed in the running out of the line which it was impossible for the lead to communicate to it. In fact but a small part of that velocity could have been produced by the descent of the lead. Here we have a reliable result to the depth of 1000 fathoms only. The difference between this result and the conclusions of Captain Denham is simply the difference between *one mile* and *nine miles*.

In measuring the distance to the sun, an error of eight miles would hardly be worth noticing, perhaps; but what conclusions can be drawn from a measurement in which the probable error amounts to eight times the whole distance?

We add a few words on the *Sounding-lead and Line.* The lead, if allowed to descend alone, will fall with a uniform and rapid velocity to the bottom. This velocity will be attained within a few feet of the surface, and will be due to the opposing forces of gravity and the resistance of the water, which will be balanced when the uniform velocity is reached. But if a line be attached to the lead, a few hundred feet of the line will offer a resistance to the motion nearly equal to the whole weight of the lead; and as successive lengths of line are drawn into the water, the resistance is constantly increased; so that at 2000 or 3000 fathoms depth, the weight will be almost entirely suspended in the sea by the resistance of the water along the sides of the line.

Some idea of the resistance which opposes the motion of a sounding-line may be formed from the fact, that upon 1000 fathoms of a line one-tenth of an inch in diameter, moving with a velocity of three feet per second, the resistance is between 25 and 30 pounds. And if the velocity be increased to six feet per second, the resistance upon the line becomes a hundred pounds nearly. Or, if the length of the line be doubled, with the same velocity, the resistance is doubled; and it is also directly proportional to the diameter of the line.

FRESH WATER FROM SEA-ICE.

To explain the observation of Dr. Kane as to the freshness of Ice formed from Sea-water under 30 deg., Dr. Walker, Surgeon and Naturalist to the Arctic Discovery Expedition, supposes that it may have depended on the freezing of a portion of sea-water which was covered at the time of its congelation with a stratum of fresh water produced by the melting of bergs. On the 12th of April, 1857, whilst lying off Brown's Island, within about four miles of the glacier surrounded by bergs, the author observed a layer of fresh water, two or three inches in depth, floating, like oil, on the surface of the salt water. To this cause he attributes the occasional occurrence of hummocks from the upper portions of which ice perfectly free from salt can be obtained, while on digging deeper into these hummocks, the ice is always found to lose its freshness.—*Proc. Royal Soc.*

DESTRUCTIVE EFFECTS OF WAVES.

MR. THOMAS STEVENSON, C.E., in a communication to the Royal Society of Edinburgh, states as supplementary to the paper describing the results of his Marine Dynamometer, that "On the Bound-Skerry of Whalsey, which is only exposed to the waves of the North Sea or German Ocean, he found, on first landing, in 1852, masses of rock weighing $9\frac{1}{2}$ tons and under, heaped together by the action of the Waves at the level of no less than 62 feet above the sea; and others, ranging from 6 to 13 tons, were found to have been quarried out of their positions *in situ*, at levels of from 70 to 74 feet above the sea; another block of $7\frac{1}{18}$ tons, at the level of 20 feet above the sea, had been quarried out and transported to a distance of 73 feet, from S.S.E. to N.N.W. over opposing abrupt faces as much as 7 feet in height." Somewhat similar evidences of the force of the sea were observed on the neighbouring islands, and more recently by Mr. David Stevenson at Balta and Lambaness (in the most northern of the Shetland Islands), who, in a report made at the time, attributes the great force of the waves in the northern regions of the German Ocean to their exposure and the proximity of deep water to the land. In addition to these causes, the author referred to the strength of the tides, the configuration of the German Ocean, and to the great depth of the water, as the probable cause why heavier waves are produced in the latitude of Shetland than are found, for example, on the coasts of England or Holland.

The author, after alluding to the writings of Mr. Airy and Mr. Webster, referred specially to this gradually decreasing general depth in passing from Shetland to Holland, as a main cause of the diminished magnitude of the undulations. That the waves are materially smaller in the southern than in the northern latitudes, may be inferred from the low, yet safe, level at which many of our southern seaport towns have been built in reference to that of high water. The author considered that another proof that this reduction of the waves depended on the reduction in the depth of water, might be deduced from the structure of the bottom. He considered that the presence of *mud* at any depth might be taken as a certain proof that the agitation, originating at the surface, had ceased to be appreciable. If the geological formation did not produce a clayey deposit, or if strong submarine currents existed, the *absence* of mud might afford no proof of the magnitude of the waves; but its *presence* in shoal water may be relied on as indicating with certainty that in whatever locality it is found there must be small disturbance at the surface, or, in other words, that there cannot be a heavy sea. Applying such a *test* to the present case—muddy deposits are found in from 80 to 90 fathoms off Whalsey, from which point southwards they are found in gradually lessening depths, till they rise to within 8 fathoms of the surface at the mouth of the Elbe. Similarly, at the Firth of Forth, the mud rises on the north side from 18 fathoms off Elie Ness to 7 at Burntisland; and on the south side, from 17 fathoms, near North Berwick, to 2 fathoms off Leith; while above Queensferry, even although the current is stronger in the higher portions of the estuary, the mud, owing to the comparative absence of waves, actually emerges above low water. It is well known, that on the banks of Newfoundland, and all round the British islands, where the bottom suddenly rises near the 100 fathoms line, the waves actually break. It seems reasonable, therefore, to infer, that the gradually decreasing depth of the German Ocean must as effectually, though not so suddenly, diminish the size of the undulations.—*Edinburgh New Philosophical Journal*, No. 19.

BALLOON OBSERVATIONS.

COLONEL SYKES has presented to the British Association the "Report of the Balloon Committee." It gave various preliminary details of the meetings and proceedings of the Committee; amongst these, that they secured the co-operation and use of the large balloon of Mr. Green. That Prof. Tyndall, and Mr. J. B. Russell, and Mr. John Murray, the two latter students in Glasgow University, who had been employed under Prof. Thomson in charge of his meteorological instruments, had volunteered their services to accompany Mr. Green, and to aid in making and recording the proposed observations. Col. Sykes also informed the committee that an observer of light weight was available from Greenwich, and also Mr. Storks Eaton, an amateur meteorologist, of Little Bredy, Dorset. The committee selected Wolverhampton as the place of ascent, spring as the time, as suggested by the Astronomer Royal, and secured through Lord Wrottesley the use of the instruments which had been used in the former ascent. The Gas Company at Wolverhampton offered the use of their yard, from which the balloon might ascend, and in which it might be inflated. Various causes of delay occurred, but eventually M. Gassiot having reported the instruments and other arrangements all ready, Mr. Storks Eaton was selected by the committee to conduct the experiments, and at length General Sabine and M. Gassiot were invited to attend at Wolverhampton on Monday, the 15th of August. On that day Col. Sykes, Lord Wrottesley, Admiral FitzRoy, Dr. Lee, and Mr. Glaisher attended at the place of ascent. In consequence of sudden violent gusts of wind that day, Mr. Green was unwilling to ascend, fearing damage to the valuable instruments; but as he declared that no damage to life was to be feared, he offered to risk the balloon if the committee wished that the ascent should proceed. The committee then ordered the gas to be laid on, but various delays having protracted the preparations to the approach of darkness, when the ascent would be unprofitable, it was deferred till next day. On that day, when all preparations were nearly completed, a sudden gust of wind jerked the funnel of the balloon, and caused such a rent as to render any attempt at an ascent on that occasion impossible. Mr. Green assured the committee it would take some weeks to repair the damage. Mr. Green's terms were 20*l*. for the first ascent, 15*l*. for a second, 20*l*. for a third, and 15*l*. for a fourth, the committee to provide the gas and to pay all incidental expenses. The committee offered to renew their operations early next year, and suggested that their reappointment should be recommended, and the grant of 200*l*. continued at their disposal, giving the opinion of Sir J. W. F. Herschel and other eminent scientific men that the objects to be attained were of the highest interest.

THE ROYAL SOCIETY MEDALS.

THE Council of the Royal Society has awarded the Copley Medal for the year to Professor Wilhelm Edward Weber, of Göttingen, for researches in electricity, magnetism, acoustics, &c. One of the Royal Medals has been bestowed upon Mr. George Bentham, for contributions to Systematic and Descriptive Botany; and the other Royal Medal to Mr. Arthur Cayley, for his Mathematical Papers published in the *Philosophical Transactions.*

THE ANGLE OF DOCK-GATES, AND THE CELL OF THE BEE.

MR. C. M. WILLICH has communicated to the *Philosophical Magazine*, No. 122, a paper upon this interesting inquiry.

"The question (says Mr. Willich) as to the proper Angle at which Dock-Gates should be placed, so that the timber employed should yield the most favourable result, has often been discussed by mathematicians, and determined as a problem of *maxima* and *minima.* The angle has been found to be 109° 28′ 16″."

A patient consideration of the properties of the cube, and its position, has led Mr. Willich to the fact that the geometrical solid, formed by the union of two cubes, having a dodecahedron with twelve rhomboidal faces, produces angles affording the greatest amount of resistance.

The obtuse angle on the face of this dodecahedron produced by the union of two cubes, as above mentioned, is the prime angle which affords the greatest resistance to water pressure in a dock-gate.

The partition of another regular solid body, the tetrahedron, effected by cutting off four smaller tetrahedrons, of half the length of the base, will leave the platonic or regular octahedron, whose eight faces are equilateral triangles—and these faces we find incline to each other at an angle of 109° 28′ 16″, thus arriving at the same angle, although we make use of two very different simple solids—the cube, and tetrahedron. There are other curious interchanges, as in the partition of the dodecahedron, the trihedral summit forms one-fourth part of a tetrahedron.

The laws of nature are always simple; we might therefore be led to expect that the same angle which is best for the dock gates, should be precisely the same as that of the trihedral roof of the bee's cell. The mode of arriving at the angle of the bee's cell Mr. Willich has shown in a letter inserted in *The Literary Gazette* of the 9th of July, explaining the manner of constructing the bee's cell, and of obtaining the angle required. The following is the letter:—

"Many years ago you inserted in your journal a paper of mine on the subject of an approximate geometrical quadrature of the circle. That approximation I afterwards succeeded in obtaining to within the $\frac{1}{1747}$th part of the side of the square sought; and the Royal Society, on the 10th of May, 1855, so far relaxed the rule adopted with reference to questions of this description as to admit the paper to be read; and a short account was inserted in their 'Proceedings.'

"I am now anxious to announce that I have succeeded in dividing the cube into several geometrical solids, with which many definite and regular geometrical bodies may be constructed.

"Perhaps one of the most curious is that of the bee's cell, which is in fact an elongated dodecahedron; and consequently the angles of the trihedral roof and base, respecting which so many learned investigations have been made, can be no other than those of the true geometrical solid.

"Without the aid of diagrams it is not easy to make the forms of solids clear to the mind in a popular way.

"A cube may be divided into six equal and uniform bodies in two different ways:—

"1st. By lines from the centre to the eight angles of the cube, which will give six 4-sided pyramids.

"2ndly. By lines from one of the upper angles of the cube, drawn diagonally to the three opposite angles, dividing the cube into three equal and uniform solids. Each of these solids being halved, forms a left- and a right-handed solid. These six solids, though equal in solidity, differ so far in shape, as three are left-handed and three right-handed, in the same way as the hands of the human body.

"Each of the six bodies obtained by the second mode of partition may be divided into two of equal solidity and of similar shape. Two of these bodies, each being one-twelfth of the cube, may be so united as to produce the pyramid obtained by the first mode of partition. Six of these bodies, each being one-twelfth part of a cube, may be so arranged as to form the oblique rhomboid.

"For the present investigation we will not proceed further than the solid thus obtained, being the one-twelfth part of the cube. By this body, by using a different number and mode of arrangement, may be produced a variety of symmetrical geometrical forms in addition to the following:—

"1. The cube consists of twelve of these bodies.

"2. The octahedron consists of four of these bodies.

"3. The oblique rhomboid consists of six of these bodies.

"4. The dodecahedron consists of twenty-four of these bodies.

"5. The dodecahedron also consists of four oblique rhomboids—or two cubes, or six octahedrons.

"The bee's cell consists of seven oblique rhomboids, or forty-two half pyramids.

"It is therefore evident that the bee's cell is an elongated dodecahedron.

"It may be observed that the pyramid, or one-sixth of the cube obtained by the first mode of partition, may be divided into four bodies, each of which is one-third of a cube containing one-eighth of the mass of the cube from which it was derived. So that, in fact, we may go on dividing and reproducing bodies of a similar shape, and still retaining the diagonal lines of the cube. How far this subdivision may be carried in nature, or how much further than our powers of vision go, I will not at present venture an opinion. We can imagine the commencing atoms may be infinitely small, when we remember the wonders revealed by the microscope."

Mr. Willich has also read to the British Association a communication upon this subject, which he illustrated with models admirably calculated to make this abstruse matter intelligible, and related a very interesting history of the speculations of mathematicians in their successive attempts to discover the angle which gave the greatest strength to support pressure with the greatest economy of materials. It proved that, though some of the mathematicians had fallen into error, the bees, by a peculiar instinct, had always used the mathematically-correct angles. The models showed exactly the manner in which the surfaces were arranged so as to produce the desired effect.

Mr. Willich proposes to illustrate, in a similar manner, the combination of many other bodies; he being of opinion that the study of geometry would be simplified by the use of models, showing how certain forms are built up with solids of a definite though not of a primitive form.

Electrical Science.

BONELLI'S ELECTRIC LOOM.

M. DE SEIMARCOURT has informed the French Academy of Sciences that M. Froment has completed important improvements in the Electric Loom invented by Chevalier Bonelli, Director of the Sardinian Telegraph, which figured at the Paris Exhibition of 1855, when a commission was named to examine it and make a report to the Academy. M. Chevreuil stated that he had been to see it at work, accompanied by the President of the Chamber of Commerce and other gentlemen, and had been astonished at the results obtained. The invention consists chiefly in replacing the Jacquard cards by a thin sheet of tin on which the design to be reproduced on the fabric is figured with varnish or isolating ink. The beat up of the batten brings a metallic comb formed of small separate teeth into contact with the design, when some of the teeth touch the varnish of the design, and others touch the metal; and those teeth in contact with the metal alone give passage to the electric fluid supplied by a Bunsen pile, and convey it to the small electro-magnets with which they are connected by means of a thin copper wire. These electro-magnets act upon an equal number of small iron rods to keep them out of the way of the wires of the Jacquard, while those teeth which come in contact with the varnish of the pattern are allowed to project against the wires of the Jacquard, to act upon them in the same manner as the cards now used. As a proof of the ease with which new patterns can be applied, when the Emperor and Empress were lately visiting the *Ateliers* to inspect the loom, M. Froment, without interrupting the work, replaced the design in course of execution by a band of tin, on which he had written the words Napoleon III., which were seen to follow on the fabric, the flowers composing the first design.

ATMOSPHERIC ELECTRICITY.

DR. JOULE has read to the Manchester Literary and Philosophical Society, the following extract from a letter from Professor W. Thomson. "I have had an apparatus for Atmospheric Electricity put upon the roof of my lecture-room, and got a good trial of it yesterday, which proved most satisfactory. It consists of a hollow conductor supported by a glass rod attached to its own roof, with an internal atmosphere kept dry by sulphuric acid: the lower end of the glass rod is attached to the top of an iron bar, by which the hollow conductor is held about two feet above the inclined roof of the building. A can, open at the top, slides up and down on the iron bar which passes through a hole in the centre of its bottom, and, being supported by a tube with pulleys, &c., below, can easily be raised or lowered at pleasure. A wire attached to the insulated conductor passes through a wide hole in the bottom of the can, and is held by a suitable insulated support inside the building, so that it may be led away to an electrometer below. To make an observation, the wire is connected with the earth, while the can is up, and envelops the conductor—its position when the instrument is not in use. The earth connexion is then broken, and the can is drawn down about eighteen inches. Immediately the electrometer shows a large effect (from five to fifteen degrees on my divided ring electrometer, in the state it chanced to be in, requiring more than one hundred degrees of torsion to bring it back to zero, in the few observations I made). When the surface of the earth is, as usual when the sky is cloudless, negative, the electrometer shows positive electricity. But when a negative cloud (natural, or of smoke) passes over, the indication is negative. The insulation is so good that the changes may be observed for a quarter of an hour or more, and when the can is put up the electrometer comes sensibly to zero again, showing scarcely any sensible change when the earth connexion is made, before making a new start." Dr. Joule stated that he had recently witnessed experiments with Professor Thomson's new atmospheric electrometer, the merit of which consisted in its extreme sensitiveness, and the facility with which accurate observations could be made with it.

ELECTRICITY OF TOURMALINES.

M. GAUGAIN, in an elaborate memoir, states that the Tourmaline becomes electric when cooled or heated between certain limits of temperature: the green and blue tourmalines of Brazil furnish the largest amount of electricity, and not the brown tourmalines as commonly supposed. M. Gaugain has also investigated the hygrometric peculiarities of the tourmaline in relation to electricity. The transparent variety is much valued for experiments on the polarization of light.

ELECTRICAL THEORY OF THE AURORA BOREALIS.

MR. GROVE, in a paper read by him to the Royal Institution, "On the Electrical Discharge and its Stratified Appearance in Rarefied Media," observes, in conclusion, that the experiments of Walsh and Morgan, corroborated by Gaissiot, go far to prove that ordinary matter is requisite for the transmission of electricity, and that if space could exist void of matter, then there would be no electricity: thus supporting the views advocated by Mr. Grove and some others, that electricity is an affection or mode of motion of ordinary matter.

The non-transmission of electricity by very highly attenuated gas may also afford much assistance to the theory of the aurora borealis, a phenomenon, the appearance of which, the regions where it is seen, its effect on the magnet, and other considerations, have led to the universal belief that it is electrical.

The experimental result that a certain degree of attenuation of air forms a good conductor, or easy path for the electrical force, while either a greater or a less degree of density offers more resistance, and this increasing towards either extremity of density or rarefaction, show, that if there be currents of electricity circulating to or from the polar regions of the earth, the return of which, as is generally believed, gives rise to the beautiful phenomena of the aurora borealis or australis, the height where this transit of electricity takes place would be just that at which the density of the air is such as to render it the best conductor. By careful measurement of the degree of attenuation requisite to enable the electrical discharge to pass with the greatest facility in our laboratory experiments, we may approximatively estimate the degree of rarefaction of the atmosphere at the height where the aurora borealis exists. By these means we get a mode of estimating the height of the aurora by ascertaining, from the decrement of density in the atmosphere in proportion to its distance from the earth, at what elevation the best conducting state, or that similar to our best conducting vacuum tubes would be found ; or conversely, by ascertaining the height of the aurora by parallactic measurements, we may ascertain the ratio of decrement in the density of the atmosphere. Thus by our cabinet experiments, light may be thrown on the grand phenomena of the universe ; and the great questions of the divisibility of matter, whether there is a limit to its expansibility, whether there is a fourth state of attenuation beyond the recognised states of solid, liquid, and gaseous, as Newton seemed to suspect, (30th query to the Optics,) and whether the imponderables are specific affections of matter in a peculiar state, or of highly-attenuated gaseous matter, may be elucidated. Though the entire solution of such questions be beyond the power of man, we may ever hope to gain approximative knowledge.

EFFECT OF PRESSURE ON ELECTRIC CONDUCTIBILITY IN METALLIC WIRES.

M. ELIE WARTMANN, of Geneva, has communicated to Major-General Sabine, the following experiments by which he has proved the Effect of Pressure on Electric Conductibility in Metallic Wires.

The method resorted to is the one devised by MM. Christie and Wheatstone, which is called the electrical bridge. The current of a Bunsen's battery of six large cells was divided between the wire to be tested (a very soft copper wire 0·05 of an inch in diameter, and covered with gutta percha) and another conductor ; both being connected with a delicate Ruhmkorff's galvanometer, so that the needle remained on the zero point. All contacts were made invariable by solderings.

No sensible effect being determined by the pressure of nine atmospheres in a piezometer, M. Wartmann used a press which enabled him to produce compressions superior to four hundred atmospheres, consequently superior to that which is suffered by an electric conductor immersed in the ocean, at a depth of 12,420 English feet. The wire, besides its coating, was preserved against permanent deformation by two sheets of thick gutta percha, placed between the steel plates which took hold of it. The experiments have shown—

1°. That a pressure of thirty atmospheres (a number relative to the sensibility of the galvanometer) diminishes the conducting power of a copper wire for electricity.

2°. That the effect increases with the pressure.

3°. That the diminution remains the same for each compression, as long as the latter does not vary.

4°. That the primitive conducting power is exactly restored when the pressure vanishes altogether.

Many interesting results flow from these conclusions. For the present, M. Wartmann adds, that the fact which he has discovered establishes a new connexion between electricity, heat, and light: for it has been demonstrated by M. de Senarmont—

a. That any artificial increase of density in a non-crystallized solid body diminishes, in the direction in which it is exerted, the conducting power of that body for heat.

b. That in homogeneous media which are in a state of artificial molecular equilibrium, the conformation of the thermic ellipsoid, either oblate or prolate, is always corresponding to that of the optic one.—*Proceedings of the Royal Society*.

ELECTRICAL "FREQUENCY."

PROFESSOR W. THOMSON has read to the British Association a paper "On Electrical 'Frequency.'" Beccaria found that a conductor insulated in the open air becomes charged sometimes with greater and sometimes with less rapidity, and he gave the name of "frequency" to express the atmospheric quality on which the rapidity of charging depends. It might seem natural to attribute this quality to electrification of the air itself round the conductor or to electrified particles in the air impinging upon it; but the author gave reasons for believing that the observed effects are entirely due to particles flying away from the surface of the conductor, in consequence of the impact of *non-electrified* particles against it. He had shown in a previous communication made to the Association, that when no electricity of separation (or, as it is more generally called, "frictional electricity," or "contact electricity,") is called into play, the tendency of particles continually flying off from a conductor is to destroy all electrification at the part of its surface from which they break away. Hence a conductor insulated in the open air, and exposed to mist or rain, with wind, will tend rapidly to the same electric potential as that of the air, beside that part of its surface from which there is the most frequent dropping, or flying away, of aqueous particles. The *rapid charging* indicated by the electrometer under cover, after putting it for an instant in connexion with the earth, is therefore, in reality, due to a *rapid discharging* of the exposed parts of the conductor. The author had been led to these views by remarking the extreme rapidity with which an electrometer, connected by a fine wire with a conductor insulated above the roof of his temporary electric observatory in the island of Arran became charged, reaching its full indication in a few seconds, and sometimes in a fraction of a second, after being touched by the hand, during a gale of wind and rain. The conductor, a vertical cylinder about 10 inches long and 4 inches diameter, with its upper end flat and corner slightly rounded off, stood only 8 feet above the roof, or, in all, 20 feet above the ground, and was nearly surrounded by buildings rising to a higher level. Even with so moderate an exposure as this, sparks were frequently produced between an insulated and an uninsulated piece of metal, which may have been about $\frac{1}{40}$th of an inch apart, within the electrometer, and more than once a continuous line of fire was observed in the instrument during nearly a minute at a time, while rain was falling in torrents outside.

IMPROVEMENT OF THE VOLTAIC PILE.

It is well known that Bunsen's Pile, which is but a modification of Grove's, consists of a glazed vessel, containing a cylindrical element of zinc, which surrounds a porous vessel filled with strong nitric acid, into which a charcoal cylinder has been introduced, the liquid in the outermost vessel consisting of water acidulated with about ten parts of sulphuric acid. Now, although this is a most powerful combination, and in general use, it has two great inconveniences; first, the quantity of nitrous vapour it evolves is highly unpleasant, and may become dangerous; and, secondly, the current produced is not of constant intensity. M. Thomas has communicated to the Academy of Sciences a modification which he has effected in this kind of pile, and which would seem to be quite free from the inconvenience alluded to. M. Thomas, in fact, shows that the development of nitrous vapour is one of the chief causes which interfere with the constancy of the current, inasmuch as they attack the copper riband forming the electrodes, and effect certain chemical combinations, which give rise to counter-currents, and thus impair the principal one. He therefore causes these gases, as they are evolved, to pass into a porous vessel, where they are decomposed. In this process a secondary current is produced, which, by the peculiar construction of the apparatus, is turned to account, and tends to correct the inequalities of the principal current. This arrangement too prevents the pile from becoming dirty, as is the case with Bunsen's pile.—*National Magazine.*

RAPIDITY OF SIGNALLING THROUGH LONG TELEGRAPH WIRES.

Mr. F. Jenkins has read to the British Association a paper detailing certain experiments undertaken at the establishment of Messrs. R. S. Newall and Co., Birkenhead, with a view to verify the theory of retardation, and to supply certain constants required. This theory has been well developed by Prof. Thomson, and is confirmed by the results of these experiments, which have indeed only been rendered possible by the peculiar construction of Prof. Thomson's marine galvanometer. In this instrument momentum and inertia are almost wholly avoided by the use of a needle weighing only 1½ grain, combined with a mirror reflecting a ray of light which indicates deflexions with great accuracy. By these means a gradually increasing or decreasing current is at each instant indicated at its due strength; thus, when this galvanometer is placed as the receiving instrument at the end of a long submarine cable, the movement of the spot of light consequent on the completion of a circuit through the battery cabl and earth, can be so observed as to furnish a curve representing very accurately the arrival of an electric current. Lines representing successive signals at various speeds can also be obtained, and by means of a metronome, dots, dashes, successive A's, &c., can be sent with nearly perfect regularity by an ordinary Morse key, and the corresponding changes in the current at the receiving end of the cable accurately observed. The strength of the battery employed was found to have no influence on the results; curves given by batteries of different strengths could be made to coincide by simply drawing them to scales proportionate to the strengths of the two currents. It was also found that the same curve represented the gradual increase of intensity due to the arrival of a current, and the gradual decrease due to the ceasing of that current. The curves of arrival obtained for lengths of from 1000 to more than 2000 nauts were found to agree very closely in general appearance with those given by Prof. Thomson's theory (*Proceedings of the Royal Society*, May, 1855). In the curves representing dots and dashes sent at high speeds, successive dashes appear in quite a different part of the scale from that occupied by dots. It is in these cases obvious that no delicacy of relay will enable us to indicate both of these signals at a constant adjustment, nor does any increasing strength of battery help us—for though the variations of intensity are absolutely increased, the relative position of such changes to one another on the scale remains unaltered. The magnitude of the first appearance of a current at the far end of a cable may, however, be increased by the use of powerful batteries, and delicate instruments would permit the faintest appearance to be observed. By these means one isolated signal might be sent with great rapidity.

Returning to the consideration of successive signals, when the speed of transmission is diminished, the oscillations of the spot increase in size, those for dots and dashes overlap one another, and would give legible Morse signals by means of a relay. The amplitudes of oscillation representing any letter or letters were found to be proportional to the amplitude representing dots. The speed of signalling possible can therefore be measured by that amplitude as soon as in one case it is determined what speed of dot signalling is compatible with the reception of all other combinations of dots, dashes, and spaces. This amplitude is modified by the nature of the receiving instrument, by the nature of the signal, by the skill of the manipulator, &c. The possible speed of signalling was found to be very nearly proportional to the squares of the lengths spoken through; thus, a speed which gave 15 dots per minute in a length of 2191 nauts, reproduced all the effects given by a speed of 30 dots in a length of 1500 nauts. At these speeds, with ordinary Morse signals, speaking would be barely possible. In the Red Sea, a speed of from 7 to 8 words per minute was obtained in a length of 750 nauts. This result agrees very closely with the deduction from the experiments at Birkenhead, and apparently shows that the influence of electro-magnetic induction, due to the disposition of the cable in coils, does not very materially retard the possible speed of signalling. The amplitudes of oscillation representing dots can be thrown into a curve which will be the same for all lengths. By this curve we can determine from one single observation, on any cable, the amplitude of oscillation due to any speed, and, consequently, the possible speed of signalling on that cable. This method, however, of determining the possible speed of signalling, presupposes that a considerable length of the cable shall have been manufactured. Mechanical senders, and attention to the proportion of the various contacts, would materially increase the speed at which signals of any kind could be transmitted. The best trained hand cannot equal the accuracy of mechanism, and the slightest irregularity causes the current to rise or fall quite beyond the limits required for distinct signals. No important difference was observed between signals sent by alternate reverse currents, and those sent by the more usual method. The amplitude of oscillation, and consequent distinctness of signalling, was quite the same in the two cases. An advantage in the first signals sent is, however, obtained by the use of Messrs. Siemens and Halshe's submarine key, by which the cable is put to earth immediately on signalling being interrupted, and the wire thus kept at a potential half way between the potentials of the poles of two counteracting batteries employed, and the first signals become legible, which, with the ordinary key, would be employed in charging the wire.—*Athenæum Report.*

TRANSMISSION OF ELECTRICITY THROUGH WATER.

MR. J. B. LINDSAY has communicated to the British Association the following results. The author has been engaged in experimenting on the subject, and in lecturing on it in Edinburgh, Glasgow, and other places since 1831. He has succeeded in Transmitting Signals across the Tay and other sheets of water, by the aid of the water alone, as a means of joining the stations. His method is to immerse two large plates connected by wires at each side of the sheet of water, and as nearly opposite to each other as possible. The wire on the side from which the message is to be sent is to include the galvanic battery and the commutator or other apparatus for giving the signal. The wire connecting the two plates at the receiving station is to include an induction coil or other apparatus for increasing the intensity, and the recording apparatus. The distance between these plates he distinguished by the term "lateral distance." He found that there was always some fractional part of the power from the battery sent across the water. There were four elements on which he found the strength of the transmitted current to depend: first, the battery power; second, the extent of surface of the immersed metal sheets; third, the "lateral distance" of the immersed sheets; and, fourth, in an inverse proportion, the transverse distance, or distance through the water. As far as his experiments led him to a conclusion, doubling any one of the former three doubled the distance of transmission. If, then, doubling all would increase the intensity of the transmitted current eightfold, he entered into calculations to show that two stations in Britain, one in Cornwall and the other in Scotland, and corresponding stations well chosen in America, would enable us to transmit messages across the Atlantic.

The Earl of Rosse said he was aware that some years since experiments were made on the subject treated of by Mr. Lindsay, and messages sent across the Serpentine, but as nothing further appeared to have come from them, he supposed there were found to be practical difficulties which proved insuperable. Sir D. Brewster said he was a member of the Committee entrusted with the making the experiment alluded to by Lord Rosse during the Great Exhibition. The results were, messages were sent across in the usual manner: the wire was then broken; with a gap of six feet the messages still went, and when the distance was increased to sixteen feet and twenty feet, they still went across. In reply to the Astronomer Royal, Mr. Lindsay then drew on the board a diagram, roughly illustrating his method. In the evening, upon the sheet of water below Aberdeen Harbour, experiments were exhibited, and proved quite successful across the widest expanse upon which they could be tried, between 500 and 600 feet.

IMPROVED ELECTRO-TELEGRAPHY.

At Portsmouth Dockyard, a telegraphic wire insulated with india-rubber has been in use across the harbour ever since 1846, and the insulation is still quite perfect. The difficulties attendant on the manipulation of india-rubber have prevented its keeping its position in the face of the more easily handled gutta percha, and the peculiarities of treatment by means of which the spiral twist is now rendered quite homogeneous and perfectly solid. Moist heat is the agent used. India-rubber even still cannot be drawn on the wire like maccaroni, in the way that gutta percha, from its plasticity at a low temperature, is managed. It is generally admitted that gutta percha has been a failure both by land and sea. According to Mr. Wildmane Whitehouse's statistics, india-rubber retains ten times as much electricity for a given period as gutta percha.

The Globe Telegraph has been patented by Mr. S. Beardmore. In it the earth is used for the transmission of Electric Signals. The idea (and it is said the fact) upon which the patent alluded to is based is, that plates of positive and negative metal, placed in the earth, at each extremity of, and connected with, a single line of wire running between them, will themselves evolve sufficient electricity for the transmission of messages. Not only so; but that the size of plates required is astonishingly small. Thus it is believed, that "all the surface required for telegraphic purposes between St. John's (Newfoundland) and Valentia (in Ireland), can be contained in three boxes at each station, respectively twelve inches long by twelve inches broad, and six inches deep."

Insulating Wires.—Mr. J. Macintosh has patented improved Insulation telegraphic Wires or conductors, and of apparatus employed therein, part of which is applicable to the manufacture of india-rubber tubes.

The present inventor patented certain grooved rollers on the 14th of May, 1858, for coating telegraph conductors with india-rubber. He now places other rollers in contact with the grooved rollers, one at each of the points where the india-rubber is fed into the grooves, and on these secondary rollers are formed beads adjusted so as to fall exactly in the middle of the grooves of the principal rollers, so that they form indentations in the india-rubber suitable to receive the wire or conductor. With soft india-rubber, he mixes an equal weight of shellac ground fine, and without any solvent, by means of crushing rollers. In some cases, after having coated the wires with insulating material, he again covers them with gutta percha, or other material, with which unspun fibre is intimately mixed. Sometimes it is desired to cover conductors with insulating material, and at the same time to combine yarns with, or imbed them in, the covering. For this purpose he employs a cylinder closed at the ends, with a screw just fitting within it, mounted on a hollow axis passing through the ends of the cylinder. Through this axis the yarns and the wire or conductor to be covered pass, and the bobbins from which the yarns are drawn are mounted on a frame fixed on the end of the same axis. The cylinder has an opening in its side near the end, at which the yarns enter for feeding in the gutta percha. When the axis is caused to rotate, the gutta percha is pressed out at the end of the cylinder, and passes into a small box furnished with a die, and so that the yarns become imbedded in the covering. When employing more than one coating to a conductor he causes a current of cold air to impinge on the covered wire after the first coating, so as to bring it rapidly to such a consistency that the second coating may be applied without injuring the first.

India-rubber Insulation.—The desirability of substituting India-rubber for Gutta Percha, as an insulator, has been experimented on with success at Messrs. Silver and Co.'s establishment at North Woolwich. Mr. West, inventor of the india-rubber covered wire, conducted the experiments, and gave an account of his researches in connexion with the process. As long ago as 1838 he commenced using india-rubber for insulating wires. In 1845 he entered into an arrangement with Sir Joseph Paxton, Mr. Charles Dickens, and other gentlemen, to lay down a submarine cable between France and England, on the caoutchouc insulating principle; but, although the sanction of the English Government was obtained to the undertaking, that of the French Government was withheld for so long a period as to render it impossible to carry it out at that time. But in 1846 a portion of the cable which had been made by Mr. West, to lay down across the Channel, was with the consent of the Lords of the Admiralty, submerged in Portsmouth harbour, and a letter was read from Mr. Hay, the chemical referee and lecturer attached to the dockyard, dated May 25, 1859, in which Mr. Hay states that, notwithstanding that the cable in question has been in constant use, exposed in places to the sun, strained over rough stones, frequently coiled and uncoiled, and treated very roughly, the insulation is now quite perfect, although thirteen years have elapsed since it was laid down. A portion of this cable was exhibited. Mr. West's improvements, for which he has taken out a patent, consist in manipulating and applying the india-rubber. In consequence of this substance not becoming plastic at a low temperature, it is impossible to draw it on the wire like maccaroni or gutta percha; it is, therefore, wound spirally round it; but as caoutchouc is not homogeneous, and the want of cohesion in the overlapping would render it liable to the permeation of water, Mr. West was under the necessity of inventing a method of overcoming this defect. The experiments testified that he has perfectly succeeded, and specimens of his cable, which were exhibited, showed that the india-rubber is rendered perfectly solid and homogeneous. The quick and easy manner in which it can be repaired in case of abrasion or cutting is another great advantage of his process, while experiments showed that the electric fluid is transmitted without lateral loss, thereby rendering the use of batteries of great power unnecessary. It has been ascertained that india-rubber insulates ten times better than gutta percha, which is too porous to admit of perfect insulation. Care must be taken, however, to use the Para caoutchouc, as that derived from the East Indies is of an inferior quality and becomes "treacley," and consequently unfit to act as a good insulator. Careful experiments, made to test the resistance of the india-rubber covered wire to great atmospheric pressure, showed that with a pressure of 1300 atmospheres, equivalent to between two and three times that of the greatest depth of the Atlantic, insulation remained perfect.—*Athenæum*, No. 1649; *abridged*.

Telegraphing across the Tay without Wires.—The *North British Mail* says: We have received the following note from Mr. J. B. Lindsay reporting progress with his experiments. The results, it will be seen, are highly encouraging: "Yesterday (May 17) I telegraphed successfully across the Tay, opposite to Glencarse, where it is about half-a-mile broad. The action on the needle was strong, and the same battery-power would cross, I think, at Broughty Ferry."

The Micro-Electric Telegraph, invented by Mr. Isham Baggs, consists of a combination of optical, chemical, and electrical apparatus, and it promises to maintain in a state of permanent efficacy, under all the various conditions of weather and humidity, any line of telegraph, short or long, to which it may be applied. It is very well known that all suspended lines of telegraph are liable to derangement in a humid state of the atmosphere, and that the effective action of the current under these circumstances is greatly weakened—so much so, that the needles or other indexes of electric communication, are frequently rendered thereby so faint and sluggish in their movements, as to become practically useless. The reason of this is that wherever a mass of matter, great or small, is required to be moved, a certain amount of force is required to move it, and that in proportion as the preponderance of power over friction and other opposing influences is diminished, so is the resulting motion decreased, both in amount and velocity. In other words, an electric current or impulse despatched from London may reach Newcastle or Aberdeen, but in so impaired a state with reference to quantity, as to be unequal to the task of executing its mechanical functions.

In the present invention the movement of particles is substituted for that of masses, so that any quantity of electricity, however minute and otherwise inappreciable, cannot fail to produce a certain corresponding effect. A single wire is the medium of communication, and the earth, as at present, completes the circuit.

Let us suppose a case, and assume that we have a long line of telegraph in a most defective state of insulation from wet or otherwise, and that only the one-hundredth part of the electricity despatched from one terminus is capable of reaching the other; then that one-hundredth part, which will not move a needle or stir a magnetic armature, is still capable of decomposing a definite amount of water, and of liberating a corresponding quantity of gas. Of course the quantity of gas so liberated is very small; still the results are always manifest, for the inventor works the decomposition trough in the focus of a powerful oxy-hydrogen microscope, and throws upon a screen a refracted image of the wires and the liberated bubbles of gas, magnified to the extent of *six millions of times their actual sectional dimensions*. In very extreme cases this power, great as it is, is made to undergo a further extension, and the gas bubbles so produced are generated under a vacuum, whereby a greatly increased augmentation of volume is realized. Suppose, for instance, the vacuum is equal to half an inch of mercury, then the increase of volume would be sixty times that of the original, and though in such case the increase in sectional area would be only as the square of the cube root of expansion, yet here, as the visibility of the result depends not merely upon length and breadth, but also upon apparent thickness, the true increase of value in the manifestation of the signals is directly as the expansion itself. The effect therefore produced upon the screen is amplified THREE HUNDRED AND SIXTY MILLIONS OF TIMES its actual size when viewed by the naked eye. After stating such a fact as this, it appears to us to be quite unnecessary to dilate upon its application. It simply amounts to this, that wherever the faintest current of electricity traverses an electric wire, it can be rendered visible in its effects, and used as an ever-ready and effective substitute under the worst conditions for the existing telegraph. We have illustrated the matter by the adduction of a very extreme case. In ordinary practice an Argand lamp, or the light of day, when available, is ample for all purposes, and when the wires are short, or the electricity is abundant, no amplifying power whatever is required.—*Mechanics' Magazine*, Feb. 18.

Automatic Writing Telegraph.—Professor Wheatstone has supplied to the French Academy of Sciences a full description of his Automatic Writing Telegraph, by which 50,000 letters may be printed off per minute. It consists of four distinct contrivances, viz.—1. A perforator, for the purpose of piercing holes in a long slip of paper, the relative position and number of these expressing the letters of the alphabet. 2. A transmitter, which receives the perforated slips of paper, and transmits the electric currents, produced by a voltaic pile, in the order and direction determined by the holes in the paper. 3. A receptor, or apparatus, which, at the receiving-station, marks on a paper certain black points, corresponding to the holes already mentioned made in the paper at the transmitting station. 4. A translator, or machine by which the telegraphic marks or spots are *translated into the ordinary alphabet*. The translator has eight keys, placed in two rows of four each, with a ninth key in a separate place. By a proper combination of these keys, a wheel in connexion with them may be made to present to the paper which is to receive the impression any letter required. The ninth key prints it. All the contrivances are made to work together by means of various details, which do not admit of description here. Professor Wheatstone states that by means of this apparatus he can transmit five times as many signals to moderate distances as by the usual methods. The chief advantage of the system appears to be, that the manual operations it requires are extremely easy, and require scarcely any intellectual effort.

Long Circuits.—Mr. Alfred Varley has read to the Society of Arts a paper "On the Practical Bearing of the Theory of Electricity in Submarine Telegraphy, the Electrical Difficulties in long Circuits, and the Conditions requisite in a Cable to insure rapid and certain Communication." Mr. Varley observed that the metallic cord of a submarine cable should be composed of a conductor of the highest specific conducting capacity, that a decrease in the retardation which is caused by the induction that takes place in submarine circuits can only be obtained by increasing the thickness of the insulating material, but that it will be better to do this by enlarging the sectional area of the conductor as much as is practicable. In designing a cable there are many considerations besides those of its simple electrical qualifications which have to be entertained. The object to be obtained is the best result with the most economical investment of money. Are the proportions which were adopted in the Atlantic cable the best to insure this? The weight of the conducting coil in this cable is about 63 lbs. to the mile, the value of which, speaking roughly, would, I suppose, be about as many shillings; when served with gutta percha its value was raised to 40*l.* per mile; the iron sheathing and getting the cable on board brought its value up to 100*l.* per mile. In this cable, therefore, only four per cent., at the outside, was invested in the conductor upon which the transmission of the messages depended. If the views which I have brought forward are correct, a conductor of double the diameter would only produce half the amount of retarding force of one of half the size; such a conductor, at the very outside, would not cost more than 16*l.* per mile; and the increased expenditure in serving such a conductor with gutta percha and giving it an iron sheathing, would not, comparatively speaking, be very large. The expenses of the staff and the hire of ships would be about the same in both cases. The latter would be, perhaps, increased slightly, but not to any material amount.

Improved Signals.—Dr. Joule has exhibited to the Manchester Literary and Philosophical Society several slips of paper, having messages inscribed upon them by Professor Thomson's new Electric Telegraph Apparatus. In these specimens, the marking consisted of a succession of minute perforations, produced by sparks from an inductive coil apparatus, while the paper was gradually drawn through the machine. The sparks are directed to the paper by a fine platina wire affixed perpendicularly to a light arm attached to a small magnetic needle suspended within a coil of wire. The directive tendency of the needle is made very great by means of adjacent steel magnets. So long as either no current or a uniform flow passes through the coil, the perforations go on in a straight line. To produce signals, temporary electric currents of longer or shorter duration are transmitted. The magnetic needle carrying the platina wire is thus deflected, causing the line of perforations to assume the shape of a succession of letters V of various width and at various distances asunder, and in this way letters and words are indicated by the use of a given code of signals. The chief advantage of this system of telegraphic recording is, that it gives clear legible signals when a "relay" is entirely thrown out of action by inductive embarrassment. It has also the advantage of showing clearly signals superimposed on earth currents. The signal, superimposed either on the large swell or wave of induction or of an earth current, is like a ripple seen distinctly on a large wave. Dr. Joule stated that Professor Thomson had recently discovered the means of giving a surer direction to the electric sparks, and of producing a very considerable increase in the size of the perforations produced by them. He also remarked that the system above described was similar in principle to that employed by Professor Thomson in transmitting the whole of the messages which had crossed the Atlantic from either side. To him, therefore, the merit of having given a temporary success to the Atlantic telegraph exclusively belongs.

DISCHARGE OF A COILED ELECTRIC CABLE.

THERE have been read to the British Association the following "Remarks on the Discharge of a Coiled Electric Cable," by Professor W. Thomson. Mr. Jenkin had communicated to the author during last February, March, and April, a number of experimental results regarding currents through several different electric cables coiled in the factory of Messrs. R. S. Newall and Co., at Birkenhead. Among these results were some in which a key connected with one end of a cable of which the other end was kept connected with the earth, was removed from a battery by which a current had been kept flowing through the cable, and instantly pressed to contact with one end of the coil of a tangent galvanometer, of which the other end was kept connected with the earth. The author remarked that the deflexions recorded in these experiments were in the contrary direction to that which the true discharge of the cable would give, and at his request Mr. Jenkin repeated the experiments, watching carefully for indications of reverse currents to those which had been previously noted. It was thus found that the first effect of pressing down the key was to give the galvanometer a deflexion in the direction corresponding to the true discharged current, and that this was quickly followed by a reverse deflexion generally greater in degree, which latter deflexion corresponded to a current in the same direction as that of the original flow through the cable. Professor Thomson explained this second current, or false discharge, as it has since been sometimes called, by attributing it to mutual electromagnetic induction between different portions of the coil, and anticipated that no such reversal could ever be found in a submerged cable. The effect of this induction is to produce in those parts of the coil first influenced by the motion of the key a tendency for electricity to flow in the same direction as that of the decreasing current flowing on through the remoter parts of the coil. Thus, after the first violence of the back flow through the key and galvanometer, the remote parts of the cable begin, by their electro-magnetic induction on the near parts, to draw electricity back from the earth through the galvanometer into the cable again, and the current is once more in one and the same direction throughout the cable. The mathematical theory of this action, which is necessarily very complex, is reserved by the author for a more full communication, which he hopes before long to lay before the Royal Society.

THE ATLANTIC CABLE.

Mr. J. N. Hearder, the electrician, of Plymouth, in a paper read at the Plymouth Institution, and Devon and Cornwall Natural History Society, examines in considerable detail a few of the peculiarities of the Atlantic Cable, together with the electrical appliances employed, with the view of ascertaining their suitability, and thence draws some practical conclusions for future guidance. The entire paper has been communicated by the author to the *Philosophical Magazine*, No. 111. We have only space for the author's conclusion.

In order to provide a current suitable for the capacity of the enormous primary wires of these induction coils, gigantic batteries were constructed, consisting of 400 plates of silver 9 inches square, and the same number of similar plates of zinc, which were fitted into 20 gutta percha troughs, each containing 20 alternations of zinc and silver. The 20 silver and 20 zinc plates in each trough were arranged as single pairs, all the silver being united at the top, and all the zinc at the bottom. The whole battery thus consisted of 20 pairs of plates, each containing 22½ square feet of silver, calculating both sides in action. These stupendous batteries were mounted in ponderous iron gimbels for the sake of stability on board ship; the cost of the silver was about 2000*l*., and that of the whole batteries, independently of coils or other apparatus, about 3000*l*. Subsequently, however, from some experiments with plates of gas carbon, it was discovered that these were more energetic in their action than silver plates, and accordingly the electrician of the Company deemed it advisable at once to discard all the latter, and introduce plates of gas carbon in their place.

Bearing in mind the tiny character of the Atlantic wire, one is irresistibly led to inquire what end such a battery as this was destined to accomplish, and whether the same end might not have been attained by much smaller means.

Its object, then, is not to generate a current of electricity to be passed through the cable, but through the primary wires of the induction coil, in order to excite magnetism in its iron core; and it is the magnetism thus excited which has to react upon the secondary coil, and generate the current of electricity which is to be employed for working through the cable. The electrician will not fail here to predicate many chances of loss of power, if the conditions requisite for developing the greatest amount of magnetic power in the iron core, as well as for turning to the best account the magnetism thus obtained in the production of a secondary current, be not observed. The effects at present produced by these induction coils, as I have before remarked, indicate serious losses somewhere; but whether they arise from a faulty principle or defective workmanship, is a problem yet to be solved.

I cannot conclude this paper without offering an opinion or two on the present cause of failure of the Atlantic Cable, and the ultimate prospect of success. Had the cable been tested in water, after completion, which might have been readily done at Keyham Dockyard, defects might have been easily discovered and repaired. The omission of this test leaves much room for speculation as to the cause or seat of the injuries or defects. I have no faith in the modes which have been adopted to discover their situation, so far as I have become acquainted with them, though I believe that the proximate determination of these particulars is still attainable. A consideration of the mechanical construction of the cable shows that it is very liable to injury in the process of laying. I have seen some specimens recovered after immersion, which were kinked in such a manner as to strain and injure very materially the gutta percha coating of the conductor, which having nothing but its own tenacity to depend upon, would be subject to enormous tension by the lengthening of the external iron covering. With electricity of such high tension as that required to work through the wire, the smallest fissure or defect in the insulating coating would form a leak of a much more formidable character than if it existed in a wire of moderate length: and the fact of working to earth increases the tendency to lateral discharge. If, however, the faults be not discovered and remedied, the cable, although useless for the purpose for which it was originally intended, may still render valuable assistance to the success of future lines by being employed as a wire for the return current, instead of employing the ordinary mode of working to earth—a practice which appears to me, in relation to submarine cables, to be highly objectionable. The employment of a return wire, especially of a large conducting capacity, would prevent much of the inductive action which now takes place between the inner conductor (the wire) and the outer conductor (the sea). I believe also that a current of moderate quantity and high tension, such as is developed in my own form of the induction coil, (*Philosophical Magazine*, Dec. 1856,) would be far better calculated to overcome the difficulties met with in the Atlantic, or other submarine cables, than the contrivances which have been hitherto adopted.

The following Report of Mr. F. C. Webb. C.E., has been made to the Chairman and Directors of the Atlantic Telegraph Company:—

"Valencia, August 10. Gentlemen,—According to your request I made from Valencia a careful examination of the electrical state of the Atlantic cable. I made some tests for comparison on the various pieces of Atlantic cable in Messrs. Glass's premises at Greenwich during July 31 and August 1. I arrived here on the 4th inst., and, assisted by Mr. Collett, made experiments during the 5th, 6th, 8th, and 9th inst. I find the lowest resistance shown to be 278 statute miles. I find it is possible to increase this resistance up to 589 miles, by sending a copper current for some time from six 12-plate Daniell's batteries. By experiments I have made on various kinds of constructed faults, I find that a fault which could be thus oxidized so as to give (by reversal of the current) a difference of resistance equal to the difference obtainable on the cable, viz., 311 miles, must give a *minimum* resistance of about 16 miles. When the fault is large, and thus gives little resistance, no great change can be obtained by reversing the battery: and, indeed, it is evident that when the connexion between the line and earth is increased beyond a certain extent of surface, no difference in the resistance of the circuit can be obtained by reversing the battery. When the fault is very minute, it can be almost perfectly sealed up by a copper current, but the resistance will still be very great, even with a zinc current. My experiments show that a fault of about 16 miles minimum resistance can be varied with certainty by reversal of the battery to the same degree as the fault in the cable, and that if the fault gives less resistance than 16 miles it cannot be varied to that extent, while, if it gives more resistance, the variation cannot be produced with the same certainty, nor quite to the same degree. Taking, therefore, the resistance of the fault and cable beyond the fault to be equal to 15 miles, this would bring the fault to about 263 statute miles from Valencia. As I have no information of the return current due to different lengths of the Atlantic cable, which might have been observed and tabulated during the paying out of the cable, it is impossible to check the resistance tests accurately by the observed return current. Comparing it, however, with the return current on the Cagliari and Malta and Corfu cables, and making, roughly, allowance for the increased size of the gutta percha in the Atlantic cable, I find it to be about what is due to the supposed distance of the fault. I also made experiments on the return current with a wire leading to earth from the cable, and by placing resistance in circuit in this wire I could represent a fault close at hand and of varying resistance. I found that in such an arrangement, when the artificial fault gave a resistance of 300 miles, the return current was only reduced about 22 per cent. If the real fault, therefore, was close at hand, the return current of the whole length of perfect cable beyond the fault would be only reduced about 22 per cent. also. I am of opinion that the observed return current is much less than 78 per cent. of the return current due to the whole cable, as it would be if the fault were close at hand and of a resistance of about 300 miles, and that it coincides, as nearly as I can judge, with that due to the length shown by the resistance. Again, when the artificial fault was made to represent a resistance of 260 miles, and then increased to 580, the return current only increased about 17 per cent., whereas when the real fault is increased to the same amount of resistance (by sending a copper current for some time) the return current increases about 80 per cent. This shows also that the return current is more influenced by the partial healing of the fault than it would be if the fault was a small one near at hand, and consequently tends also to confirm the supposition that the fault is distant, and offers, when at its minimum, little resistance. I am of opinion, therefore, that a serious fault exists about 263 statute miles from Valencia, measured along the cable, and that the cable between that spot and this shore is comparatively perfect. No tests from here can now decide whether the cable is mechanically severed, since all attempts to detect the reception of the most intense currents from the opposite shore have long since proved fruitless. Still, from the various circumstances attendant on the decline of the insulation, there is every reason to believe that the continuity both of the cable and the conductor is perfect. Whether any other faults exist beyond the one alluded to, it is impossible to ascertain by tests from Valencia. The fact that the signals received at Valencia were always better than those received at Newfoundland proves, undoubtedly, that the worst insulation has always been near Valencia; and, therefore, it seems probable that if the fault which exists on this coast, and which, very likely, forms the principal cause of leakage, could be removed, the insulation would be so far improved as to render the cable again available for signalling, provided the fault which is said (by those who have tested from Newfoundland) to exist in Trinity Bay was also repaired."

The following statement of the actual number of messages that passed across the Atlantic during the time when the condition of the wire was still doubtful, will show clearly how complete was the success, and how great the certainty that submarine lines will ultimately be laid. Exclusive of conversations amongst the clerks, 97 messages, consisting of 1002 words and 6476 letters, were sent from Valencia to Newfoundland, and duly comprehended; while 269 messages, of 2940 words and 13,743 letters, were received from Newfoundland in Ireland. This gives a total of 366 messages, consisting of 3942 words, made up of 20,219 letters, actually transmitted.—*Westminster Review*, No. 32, N.S.

The Magnetic Telegraph Foreshadowed.—In *Bailey's Dictionary*, edition of 1730—127 years ago—under the word "Loadstone," is the following foreshadowing of the electric telegraph:—"Some authors write that, by the help of the magnet or loadstone, persons may communicate their minds to a friend at a great distance; as suppose one to be at London and the other at Paris, if each of them have a circular alphabet, like the dial-plate of a clock, and a needle touched with one magnet; then at the same time that the needle at London was moved, that at Paris would move in like manner, provided each party had secret notes for dividing words, and the observation was made at a set hour either of the day or of the night; and when one party would inform the other of any matter, he is to move the needle to those letters that will form the words that will declare what he would have the other one know, and the other needle will move in the same manner. This may be done reciprocally."

THE TASMANIAN SUBMARINE CABLE.

THE first Submarine Electric Cable of any considerable length in this part of the world has been successfully laid and opened for public use. The 120 miles of Bass' Straits is thus annihilated, so far as the communication of intelligence is concerned, and the island of Tasmania is for many important purposes as closely united to the mainland of Australia as though no sea rolled between them. This, it will be admitted, is a work of some magnitude for these colonies; and is creditable to the enterprise of Victoria and Tasmania, who have themselves found the whole of the funds for the undertaking. In this case the object to be gained is worth even some annual expenditure in excess of returns, if the line cannot be maintained without it; for there can be no question that to Tasmania the advantage of instant communication with these colonies must be very great. The annual trade transactions between that island and the mainland are stated by the Launceston papers to be now represented by a sum amounting to more than 1,000,000*l*. sterling, and, as the markets of the one colony are entirely regulated by those of the other, it cannot be otherwise than a matter of deep importance that a close intercommunication should exist between them. One chief source of risk and expense said to be connected with this line is, that it has been laid in four separate sections—first, from the north side of King's Island to Cape Otway on the Australian coast, then in the opposite direction from King's Island to Hummock's Island, thence to Circular Head on the north coast of Tasmania, and from that point along the coast to the entrance of the Tamar, where it joins the land line to Launceston and Hobart Town. From this arrangement the shore-ends of the cable are numerous, and all of them are said to be considerably exposed to injury from the nature of the places at which the landings have been made. Under those circumstances it is being urged upon the Governments of Victoria and Tasmania that they should at once incur the additional expense of procuring from England sufficient [illegible] cable to make good any injury which either of the four sections may sustain ; and this, we think, is a very reasonable suggestion, seeing how many chances of accident the line is exposed to.—*Australian Mail.*

THE ELECTRIC TELEGRAPH IN FRANCE.

THE *Constitutionnel* gives an interesting summary of the career and progress of the Electric Telegraph in France, based on statistics of the subject lately published. The first credit opened for the first line was by a Royal order at the end of 1844. The line was from Paris to Rouen, and was intended as an experiment. Next came that from Paris to Lille and the Belgian frontier. The advantages of the system being ascertained, rapid progress was made, especially since the establishment of the Empire ; and in 1855 all the chief towns of departments were connected by wires with the capital. In 1857 the number of stations in action was 171 ; in 1858 they increased to 193. The whole of the network desirable and contemplated is not, however, complete. Up to last year there were 13,030 kilometres of telegraph wire working in France, but many secondary lines remained to be constructed. The French railways for which concessions have been granted form an aggregate distance of more than 16,000 kilometres, and there are more than 35,000 kilometres of Imperial roads in France. Hence it is inferred that a great deal more telegraph line remains to be made

The French lines were first opened for private correspondence on the 1st of March, 1851. There were then but 17 working stations, and the number of the messages sent by the public that year was little more than 9000. In 1856 there were 360,000, in 1857 413,000, and in 1858 463,000, showing an increase of 50,000 in each of the last two years. Some rather curious details are given as to whence and whither the messages were sent, and their nature. The last quarter of 1858, during which were sent, in round numbers, 156,000 messages, was chosen for this investigation. Out of that number 98,000 were sent between the 193 French stations, and 58,000 between those stations and about 2000 foreign stations. Thus it is seen that the telegraphic correspondence with foreign countries was nearly two-fifths of the whole.

ELECTRIC LIGHT APPARATUS.

MR. C. WEIGHTMAN HARRISON, of Woolwich, has patented the following improvements. They relate to the use of mercury or other fluid or semi-fluid as an electrode in obtaining light by electricity, and consist, 1, in the employment within the lamp of a burner fed with a supply of the electrode, so that it shall remain full or nearly so during waste or consumption by the light. 2. In controlling the supply of fluid electrodes by a tap, &c., worked by electric action. 3. In forming a fluid positive compound electrode by dividing the stream so that a number of separate lights may be produced from it. 4. In maintaining by self-acting means a constant degree of separation between the point where the stream of one electrode breaks, and the reservoir of a second electrode into which the stream falls or forms contact. The patentee accomplishes this by connecting the reservoir of the second electrode to a float which is placed on the first electrode contained in another reservoir, from whence the stream issues, whereby as the float descends, the second reservoir is advanced in exact proportion to the length which the stream is diminished by reduced pressure. He also effects the same object by causing the waste or condensed fluid forming a descending stream electrode, to elevate the lower electrode or reservoir; this may be done by placing it on a float under which such waste fluid is allowed to collect. 5. In forming the reservoirs for holding fluid electrodes of a combination of lamp black or other form of carbon and silica, or of lamp black and china clay, rotten stone, &c. 6. In preventing the condensation of vapours upon the glass or case of electric lamps by a stream of liquid or air being made to flow over or upon the interior surface of the glass or case. Also by partly or wholly filling the glass or case with water, alcohol, bisulphuret of carbon, &c., and in causing it to circulate around the light, or to pass away through apparatus by which it may be filtered, and then returned to the lamp again by a pump, &c., worked by electric action. 7. In preventing the rise of vapours from the waste fluid of electrodes by the introduction of a stratum of water or other liquid into the waste pipe or reservoir.—*Mechanics' Magazine.*

MAGNETO-ELECTRIC LIGHT AT THE SOUTH FORELAND LIGHTHOUSE.

THE Upper Lighthouse at the South Foreland, near Dover, has been illuminated during the past winter by the Magneto-Electric Light, by direction of the Trinity House. The machine employed in producing this new light is the invention of Mr. Holmes, of the firm of Holmes and Warner, of Northfleet: and Professor Faraday, the scientific adviser of the Trinity House, has expressed a highly favourable opinion of the novelty. The electricity in this application is not evolved by the voltaic battery, or by chemical force, but is the result of magneto-electric induction. An electric current tends to pass along a wire whilst that wire is passing by a magnetic pole; and, by a proper exaltation of the principles evolved, and arrangement of the apparatus, the current can be increased in force till it breaks across an interval between the carbons, producing a light which for brilliancy and continuance has never been equalled.

The apparatus is thus described in the *Illustrated London News* for October 22, 1859:—To two wheels with six radial arms are fixed three series of horse-shoe or V magnets, the poles of which are so disposed that opposite poles of opposite magnets face each other, and in each ring or series is alternately north and south. The central magnet-frame is arranged between two series of helices, and the two others upon either side of the helices. In these two series, the magnets are so arranged as to be in immediate proximity to the poles of the cores of the helices. Each helix consists of a hollow core of soft iron, around which the wire is wound. The wheels are supported by a strong frame, and are set in motion by a steam-engine. A maximum speed of about 85 revolutions per minute is sufficient to obtain a powerful and continuous current of electricity, suitable for the purpose, the tremor of high speed being thus avoided. The light is stated to be visible for above 27 miles, and to be seen from the tops of the lighthouses on the coast of France.

Magneto-electricity has long been applied in the telegraph, and its extension to lighthouses promises to be of great value. A Correspondent describes the new South Foreland Light as surpassingly beautiful; and no less admirable are the skill and delicacy exhibited in the machinery, whereby permanency and perfect regularity are secured in the emission of the flashes (14,000 in each second of time) which give the illuminations.

NEW ELECTRO-MEDICAL APPARATUS.

THIS new apparatus, by M. Rhumkorff, has been exhibited and explained to the British Association by the Abbé Moigno. The Abbé briefly described Daniell's and Grove's and Bunsen's galvanic batteries, the chief objection to the two latter being the evolution of nitrous acid fumes. The peculiarity of the instrument he exhibited was, that sulphate of mercury in solution contained in two neat little cups of carbon was used to excite the zinc; a small battery of two cells, aided by a Rhumkorff's coil, packed up in a small box, constituted the apparatus.

IMPROVED GALVANOPLASTIC PROCESS.

AN improvement in the method of producing copies of busts, statues, groups, and round ornaments by the Galvanoplastic Process has just been made public. The principle of the invention is the use of conductors so arranged as to spread the electrical current over a large surface. The modes of applying differ according to circumstances. One plan is as follows:—A piece of copper, or of charcoal, is made to represent in miniature the form in outline of the object to be reproduced; this miniature conductor is attached to the negative pole, and then introduced into the interior of the mould, which, of course, is in connexion with the same pole; the whole is then plunged together in the bath. The metal is conducted by the various points of this miniature-conductor towards all the various hollows which correspond with its prominences. This, however, was but a rude form of the methods adopted. The inventor, M. Lenoir, afterwards substituted for the miniature above described, a light frame or mass formed of metallic wire or of any other conducting material, which he introduced in the same manner into the hollow of the mould; by this means he obtained a large number of conductors, which approached every portion of the interior of the mould, and formed what he calls a mass of nerves for conducting the electricity into the most intricate portions of the hollow mould. These wires also render the decomposition of the solution unusually active—so much so that the gas liberated rises constantly to the surface in large beads. The deposit, however, is made with perfect regularity and uniformity.

ELECTRO-ZINC DEPOSITS ON ENGRAVED METALLIC PLATES.

MR. H. BRADBURY[*] thus describes in the *Journal of the Society of Arts* his mode of surfacing Engraved Copper Plates with a coating of pure Zinc by Electro-metallurgical means, for the purpose of protecting such plates from wear while printing, and which coating can be removed and renewed at pleasure, with facility and without injury to the engraved plate.

To obtain a deposit of pure zinc capable of printing from 1500 to 2000 impressions or more, before requiring to be removed and renewed, Mr. Bradbury has recourse to a combined solution of chloride and cyanide of zinc, prepared as follows:—

Chloride of Zinc Solution.—In a suitable vessel dissolve one part chloride of ammonium in eight parts water; place in this a porous cell containing the same solution and a copper plate, which attach to the zinc of a Smee's battery, and in the outer cell place a plate of spelter, which attach to the silver of the above battery for 48 hours.

Cyanide of Zinc Solution.—Dissolve ½ lb. of cyanide of potassium n twelve parts of water; then add as much chloride of zinc as the solution will take up.

Mix these solutions together in equal parts; use a zinc positive pole and one of Smee's compound batteries, intensity arrangement, charged with one part of sulphuric acid to twelve of water.

In from 45 minutes to an hour a deposit of the most beautiful lustre will be obtained, capable of yielding from 1500 to 2000 impressions, and even more, according to the experience of the manipulator.

PRINTING FROM ENGRAVED PLATES.

MR. W. E. NEWTON has patented a new mode of applying Engraved Plates, or electrotype or other substitutes for such plates, to the cylinders of printing presses; and of applying other parts of such presses in combination with the cylinders to enable perfect impressions to be taken from the cylindrical surfaces of the plates.

The object here is to print very rapidly from engraved plates, &c. The surface of the plate to be printed from has a cylindrical form, so that it may be made to rotate and produce the impression on the paper, &c., as the latter moves between it and another rotating surface. The invention consists: 1, in backing the plates with a flexible but inelastic metal, and winding them upon the periphery of the printing cylinder, by drawing and bending them between the latter and the periphery of the feeding and impression cylinder, so as to make them bear evenly and solidly upon every part of the first-named cylinder, and securing them firmly thereto. It also consists in a mode of applying a clearing roller in combination with the printing cylinder and the inking roller, for removing the superfluous ink from the surface of the plates after the inking operation.

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[*] The Emperor of the French has accepted a copy of Mr. Bradbury's recent work on Nature Printing, and has been pleased to present that gentleman with a gold snuffbox, surmounted by the Imperial Crown and Cipher in brilliants.

Also in a method of applying an endless band to clear and polish the surface of the plates between the engraved lines or sunk portions which produce the impression.

DURABILITY OF ELECTROTYPE WORK.

MR. E. RICHARDSON, in a communication to the *Builder*, No. 845, gives the following information as to the probable durability of Electrotype metal, and its thickness. Mr. Richardson states that in 1844, being called upon to furnish metal medallions, &c., for the granite testimonial to Major-General Sir Alexander Dickson, K.C.B., &c., near the Rotunda, on Woolwich-common, a very exposed situation,—he suggested electrotype castings. A consultation of officers on the question followed, the results being full permission to reproduce the models in electrotype copper, which was ably executed by Mr. H. Cox, of Battersea. These castings were at that time of unusual size and thickness—viz., 2 feet 6 inches diameter, and fully an eighth of an inch thick of solid metal. This was effected also without shrinking, and every tool touch from the clay-model was reproduced. These works have been now exposed for 15 years. They weighed, Mr. Richardson believes, 30 lbs. each. No chasing was required.

On the other hand, Mr. Richardson has had for years a small brass, about 15 inches high, of his Templar, William Earl of Pembroke, produced by the old fire-process, which cost pounds to chase, obliterating every line of his original model, and weighing nearly ¼ of a cwt. When are we to rival our foreign neighbours in this important branch? The zinc Berlin process seems forgotten.

PROTECTION OF SILVERED SURFACES.

BARON VON LIEBIG has patented certain improvements in protecting the Silvered Surfaces of Mirrors, and other articles of Glass. This method consists in preparing the silvered surface of mirrors, &c., by depositing thereon a coating of copper, gold, or other metal, by electricity, combined with the use of a neutral solution of the double salt tartrate of the oxide of copper, and soda, potash, or ammonia, or an alkaline solution of gold, nickel, &c.

Chemical Science.

CHEMICAL EQUIVALENTS.

At the late meeting of the British Association, Dr. Lyon Playfair, the President of the Chemical Section, in his opening address, referred to the remarks which had been made by his predecessor in the chair, Sir John Herschel, last year, who directed attention to the great importance of studying, with increased accuracy, the combining proportions of bodies, in the hope of determining the exact numerical relations which prevail between the elements. He justly regarded it as a subject worthy of the most accurate experiment, to ascertain whether the combining proportions of the elements be multiples of the combining proportion of hydrogen, as suggested by Prout; cautioning chemists at the same time not to accept mere approximate accordances as evidence of this relation. He (Dr. Playfair) congratulated the section on the publication of the laborious investigations of Dumas on this important inquiry. It required a chemist of great manipulative skill, as well as of fertile experiment, to obtain combining numbers for the elements upon which a greater reliance could be placed than upon those determined with such admirable precision by Berzelius, the great master of analysis. The atomic weights found by that chemist did not, for many of the simple bodies, confirm the suggestion of Prout as to the multiple relations of these numbers to the equivalent of hydrogen. At the same time, the more recent determinations for the atomic weights of carbon, silver, and some other elements, so closely coincided with this view, that it was very desirable to extend new experiments to the bodies which had fractional atomic weights assigned to them. In M. Dumas' *Memoirs* there were the results, though not the details, of a large series of experiments on many of the elements. He obtained numbers of precisely the same values as those obtained by the Swedish philosopher—numbers which are not multiples of the equivalent of hydrogen. But when he applied his methods of discovery and inventiveness to the further investigation of the subject, it was found that atomic weights could be deduced which were multiples of that of hydrogen, or at least stood in a very simple relation to it. Hence the general views of Prout, that the equivalents of the elements compared with certain unities are represented by whole numbers, seem to be supported by recent experiments, although it would be premature to say that there are no exceptions to the law.

He referred also to the proposals which had been made by some chemists, to double the equivalent numbers for oxygen and carbon, but expressed himself unfavourable to such a change at present.

SENSATION OF HEAT CAUSED BY CARBONIC ACID.

A communication has been made to the French Academy of Sciences on this subject. One of the most singular properties of this gas, says the report, is its decided effect upon the skin. All parts of the body that come in contact with it feel immediately an extraordinary increase of heat, which is not exhibited by the thermometer. A person placed in a room heated to 20° Centigrade, and plunging his naked arm into a receiver full of carbonic acid gas, feels as though he had put his arm into something 15 or 20 degrees hotter than the air of the chamber. This property has been turned to account medically in thermal establishments where baths and *douches* of the gas, sometimes pure and sometimes mixed, have been administered to invalids, but we are not told with what effect. M. Boussingault says that in a trench of an old sulphur-mine in New Grenada, he was almost suffocated and thrown into a violent perspiration by this gas, the heat of which he believed, at the time, to be equal to 40°, but his thermometers, after being left an hour in the trench, only marked 19°, three degrees, in fact, less than the temperature of the surface in the shade. The Professor also felt a pricking sensation in the eyes from the effect of the gas, and he was assured by the miners that they almost all suffered from weakness, and that blindness was a common result of constant exposure to this gas.

BINOXIDE OF HYDROGEN.

PROFESSOR SCHÖNBEIN has made the interesting discovery that during the slow oxidation of several metals (zinc, cadmium, tin, lead, bismuth, and copper) in moist air, appreciable quantities of Binoxide of Hydrogen are formed. The Professor, for example, takes zinc filings, and makes an amalgam with mercury. This amalgam he stirs up in a tumbler with diluted sulphuric acid, by which means he reduces it to a rough powder, and after well washing it he places the powder loosely in a funnel set over a bottle, and allows a thin stream of distilled water to trickle through. The presence of binoxide in the water which has passed will be detected by the following tests, which depend on the oxidizing and reducing effects produced by the binoxide upon certain substances. Thin starch paste, containing some iodide of potassium, when mixed with the water is in a very short time coloured dark blue on adding a few drops of a weak solution of any proto-salt of iron to the mixture. This test will succeed if the water contain only one half millionth part of the binoxide. The red colour of a solution of permanganate of potash, slightly acidulated with sulphuric acid, is discharged by the dilute solution of HO_2. It will also precipitate Prussian blue from a mixture of the most dilute solutions of red cyanide of potassium and any *per* salt of iron. A dilute solution of chromic acid is a less delicate test, but it is coloured azure blue by water containing only $\frac{1}{50000}$th of the binoxide.

Water acidulated with sulphuric acid is found to give more of the binoxide than pure water, but the maximum quantity formed seems never to exceed $\frac{1}{5000}$th of the acidulated water.

Professor Schönbein supposes all slow oxidations in air to depend on what he calls the "chemical polarization of neutral oxygen," which he is inclined to suspect is also deeply concerned in animal respiration, and many other chemical actions going on in nature. —*Abridged from a letter of Professor Schönbein to Dr. Faraday, in the Philosophical Magazine.*

OZONE AND ANTOZONE.

PROFESSOR FARADAY has read to the Royal Institution a paper "On Schönbein's Ozone and Antozone." Ozone had already been before the members of the Royal Institution on two occasions: on the 13th June, 1851, when Schönbein's early views of it were given, and on the 10th June, 1853, when the results of MM. Frémy and E. Becquerel, obtained by passing the electric spark through dry oxygen, were described; and also the opinion of Schönbein respecting the entrance of ozone as such (and not as simple oxygen) into combination. Since then, Schönbein has been led to the belief that oxygen can exist in a third state, as far removed by its properties from ordinary oxygen in the one direction as ozone is in the other; and therefore, in a certain sense antagonistic to ozone. This substance he names *antozone*, and believes that it also enters into combination, retaining, for the time, its special properties. Hence there is not merely ozone and antozone, but also ozonide and antozonide compounds. Thus, permanganic acid, chromic acid, peroxides of manganese, lead, cobalt, nickel, bismuth, silver, &c., form a list of bodies containing more or less of ozone in combination; and the character of ozone, and of these bodies because of the ozone in them, is that they are electro-negative to the antozonides, *i.e.*, as copper to zinc; they evolve chlorine from chlorides; they cannot generate peroxide of hydrogen; and they render blue the precipitated tincture of guaiacum. On the other hand, oxywater and the peroxides of potassium, sodium, barium, strontium, and calcium, form a list of substances containing antozone. These bodies are electro-positive to the former; they cannot evolve chlorine from hydrochloric acid, or the chlorides; they evolve the peroxide of hydrogen when treated either by oxyacids or even the hydrochloric acid, and they not only do not render blue the white precipitated guaiacum, but they restore that which has been rendered blue by ozone to the white or colourless condition. Now when two ozonides or two antozonides are put together, with the addition of water or an indifferent acid, they mingle but do not act on each other; but if one body from each list be associated in like manner, they mutually act, oxygen is evolved from both, and ordinary oxygen is set free; or rather, as Schönbein believes, ozone separates from one body, and antozone from the other; and these uniting produce the intermediate or neutral oxygen. Thénard, who discovered the peroxide of hydrogen, showed that the peroxide of silver, when brought into contact with it, not only caused the separation of part of the oxygen of the fluid, but also itself lost oxygen, that element leaving both bodies and appearing in the gaseous state. This experiment, with others of a like nature, and many new ones, were referred to and made in illustration of Schönbein's views. As to the independent existence of oxygen in these two new and antithetical states, ozone has been so obtained, *i.e.*, out of combination, and independent of any other body; but antozone has not as yet afforded this proof of its possible separate condition. Oxywater is the compound in which it seems nearest to a free condition. As Schönbein's view includes the idea that oxygen in these two states can retain their peculiar properties when out of combination, and have them conferred otherwise than by combination, and as ozone does fulfil these conditions and does exist in the independent state, so it is important that antozone should be pursued by experiment until it gives a like result. In relation to this subject the view of Mr. Brodie should be referred to, respecting the condition of certain elements at the *moment* of chemical change, on which he published a paper in the *Phil. Trans.* for 1850, p. 759, and another in the *Chemical Society's Journal* in 1855. He assumed oxygen as capable of existing in two states; the particles being polarized to each other by the action of associated particles, and for the moment in the relation of oxygen and hydrogen to each other; he also made many numerical experiments for the purpose of obtaining the equivalent action of the oxygens assumed to be in these opposed polar states.

ARTIFICIAL FORMATION OF MINERALS.

DEVILLE and Caron have described a process by which they have prepared several crystallized minerals. The method employed consists in the action of metallic fluorides on oxygen compounds, either fixed or volatile. It requires a high temperature, but is of very wide application, as the metallic fluorides are seldom absolutely fixed. Corundum is prepared easily, and in large crystals, by introducing into a carbon crucible fluoride of aluminium, above which is fixed a small cupel of carbon filled with boracic acid. The whole is fitted with a good cover, and kept for an hour at a white heat. The vapour of the fluoride of aluminium meets that of the boracic acid; and their mutual action gives rise to fluoride of boron and to corundum, which is thus frequently obtained in crystals a centimetre in length, but of no great thickness, having the hardness and all the other physical properties of the natural corundum.

Rubies are similarly obtained, a little fluoride of chromium being added to the fluoride of aluminium: the operation is conducted in crucibles of alumina, and the boracic acid placed in a cupel of platinum. Blue sapphire and green corundum are produced under similar circumstances, the difference in colour arising from the difference in the quantity of chrome. Cymophane, obtained by the action of boracic acid on fluoride of aluminium and glucinum, resembled the American specimens. Gahnite was obtained by placing a mixture of fluoride of aluminium and fluoride of zinc in vessels of iron, containing boracic acid placed in a platinum tray. The Gahnite is deposited on the various parts of the apparatus, in very brilliant regular octahedra coloured by the iron.

When the boracic acid is replaced by silicic acid, and volatile fluoride employed, crystallized silicates may be obtained. In this manner staurotide was obtained in form and in composition like the natural mineral. It is also obtained by heating alumina in a current of gaseous fluoride of silicon. The alumina becomes changed into cruciform crystals which have the composition of staurotide.

Rutile was obtained by the decomposition of a fusible titanate, more especially titanate of protoxide of tin, with silica.—*Comptes Rendus; Philos. Mag.*, No. 114.

FORMATION OF DIAMONDS.

SIMMLER suggests that Diamond may possibly be a product of crystallization from liquid carbonic acid. Diamond often contains cavities, and, as Brewster has observed, with accompanying circumstances which point to a strong pressure in the interior, although he does not state whether they contained water.

Brewster explained his observations of the coloured rings with the black cross around the cavities, by ascribing to the diamond a gummy consistence and vegetable origin. Simmler suggests that it may rather be compared to that of unequally compressed glass.

To confirm this view of the formation of diamonds, it would be necessary to prove that liquid carbonic acid possessed a solvent power for carbon similar to that which bisulphide of carbon has for sulphur, or liquid sulphide of phosphorus for phosphorus. Experiments which Simmler made in this direction with a view of preparing liquid carbonic acid by Faraday's method, gave no results, as the tubes always exploded.—*Philosophical Magazine*, No. 114.

DRY SATURATED STEAM.

MR. MACQUORNE RANKINE, C.E., has communicated to the Royal Society a paper "On the Thermodynamic Theory of Steam-engines with dry saturated Steam, and its application to practice."

In 1849 it was demonstrated, contemporaneously and independently, by Professor Clausius and the author of this paper, from the laws of thermodynamics, that when steam or other saturated vapour in expanding performs work, and receives no heat from without, a portion of it must be liquefied. That theoretical conclusion has since been confirmed by practical experience.

The principal effect of the "steam-jacket" invented by Watt is to prevent that liquefaction.

The presence of liquid water in any considerable quantity in the cylinder of a steam-engine acts injuriously, by taking heat from the steam while it is being admitted, and giving out that heat to the steam which is about to be discharged. Most of the heat so transferred is wasted.

The only *exact thermodynamic* formulæ for the work of steam hitherto published (by the author in the *Philosophical Transactions*, 1854, and by Professor Clausius in the *Philosophical Magazine* for 1856), are adapted to steam which receives no heat in expanding.

The present paper, after recapitulating the general equation of thermodynamics, and the special formulæ for the pressure, volume, and latent heat of steam, proceeds to the investigation of the exact formulæ for the work of steam which is supplied during its expansion with just enough of heat to prevent any appreciable portion of it from condensing, for the expenditure of heat in producing and using that steam, and for its efficiency in producing motive power.

There is explained a convenient approximation to the exact formulæ, founded on the facts, that for initial pressures of steam of from 30 to 120 lbs. on the square inch (including atmospheric pressure), and for ratios of expansion up to sixteen, the pressure of saturated steam varies nearly as the seventeenth power of the sixteenth root of its density, and that the expenditure of heat in an engine in which dry saturated steam is used, expressed in units of energy, is nearly equal to fifteen-and-a-half times the product of the initial pressure and volume of the steam expended.

Lastly there are given examples of the application of the formulæ to the engines of three steam-vessels lately experimented on by the author. The displacements of those ships are from 700 to 1100 tons; the indicated horse-power of their engines from 226 to 1180; the initial absolute pressures of steam in their cylinders range from 32 to 108½ lbs. on the square inch, and the ratios of expansion from 4 to 16. In each case the difference between the results of calculation and experiment is within the limits of error of observation, and ranges from $\frac{1}{80}$ to $\frac{1}{200}$ of the actual work of the steam. The author has computed tables of the results of the formulæ, exact and approximate.

PRESERVING MILK.

The Abbé Moigno has communicated to the British Association a "New Process of Preserving Milk perfectly Pure in the Natural State, without any Chemical Agent." To preserve milk for an indefinite period is an important problem, which in France has been solved in three different modes. M. de Villeneuve was the first to preserve milk, solidifying it by the addition of certain solid ingredients, but it was no longer, properly speaking, milk. M. de Signac preserved it by evaporating the milk till it became of the consistence of syrup, rendering it a solid mixture of milk and sugar, still it could not be called milk. M. Maben also preserved it by excluding the air and exposing it to an atmosphere of steam about 100° Cent., thus depriving it of all the gases which it contained, and then hermetically sealing the filled bottles in which it had been heated. The Abbé Moigno opened a bottle which had been closed by M. Maben on the 14th of February, 1854; and after a lapse of five and a half years, he found it as fresh as it was the first day. M. de Pierre has greatly improved the discovery. The means which he employs to effect the preservation of milk is still heat; but heat applied in some peculiar way, by manual dexterity, first discovered by a Swiss shepherd. The Abbé could only state that the effect of this new method of applying heat is to remove a sort of *diastase*, or animal ferment, which exists in milk in a very small quantity, and which is the real cause of its speedy decomposition. When this species of ferment is removed, milk can be preserved for an indefinite period of time in vessels not quite full, and consequently exposed to the contact of rarefied air, a result which was not effected by the process of M. Maben or rather that of M. Gay-Lussac, as they completely expelled those gases which otherwise would have rendered it sour. The Abbé then poured from a large vessel into glasses a milk as natural, as pure, and as rich as when it was taken from the cow in the fertile plains of Normandy. Owing to its greater specific lightness cream ascends to the top of the vessel, but it can be easily made to diffuse itself through the milk by slightly shaking it before uncorking the bottle. As the vessel is not quite full, a small quantity of butter may have been formed, and the milk may have become somewhat less rich, but it will still be pure and natural milk without any strange taste.

Professor Christison said that, after tasting the specimens of the milk brought by the Abbé, he was of opinion that it was the best preserved milk he had ever tasted.

MAGNETIC PROTO-CARBIDE OF IRON FILTERS.

MR. THOMAS SPENCER, of Euston-road, has employed this new filtering and purifying medium with great success. Among its advantages are the following:—First, It deprives water of all the colour, taste, and odour which arise from organic matter, such as peat, decayed wood, or leaves; or even that arising from animal putrescence. Second, It renders most deleterious gases, including sulphuretted or phosphoretted hydrogen, perfectly innocuous, by forcing them into combination with oxygen. Third, According to the experiments of Professors Brande, Clark, and Mr. Spencer, soft water treated by the carbide, or magnetic oxide, has no action on lead. Fourth, Water so filtered does not readily give birth to animal or putrefactive vegetable life, such being a consequence of its deprivation of all free organic matter. Thus, to the water of the dirtiest ditch or shallow pond may be instantaneously imparted all the healthful qualities of that derived from a deep-seated rural spring, though without its usual hardness: the mode of conversion, too, is in principle precisely that employed by nature. To maintain the health of an army in the field during a summer campaign, filters of this material must prove invaluable; as, with the exception of saline water, Mr. Spencer has not found any that might not be drank after passing through from 8 to 12 inches of this new medium. Even the filthiest sewer water, emitted into the Thames, becomes bright and inodorous after its passage through such a filter. The action in the latter case arises from the singular power of the carbide to absorb and solidify the gaseous sulphur and phosphorus, which are always combined with hydrogen in sewer water. On the same principle, the carbide is now found to be by far the best purifier of illuminating gas that has yet been brought forward. To which may be added, the sulphur absorbed, either from sewer water or gas, is recoverable at a profit, leaving the qualities of the carbide unimpaired.

The carbide can be manufactured very cheaply. A cubic foot and a cwt. of it are very nearly equivalent, a foot weighing about 118 lbs. For purifying water, Mr. Spencer prefers that made from the Parkhead Hematite, which he found at the commencement of his experiments to be, perhaps, the purest iron ore in the kingdom. This has been since confirmed by a Board of Ordnance Commission.

Mr. Spencer thus explains the physical powers of purification possessed by carbide to arise from its singular property of attracting to, and condensing upon its surface oxygen, but without entering into chemical combination with this gas :—

> The action exercised by the carbide on oxygen may not be inaptly likened to that of a magnet on iron filings, the carbide representing the magnet, and the oxygen the filings. We have all observed that the poles of a magnet, after immersion in iron filings, come forth covered with these minute particles of iron, arranged in striæ. Thus, they are first attracted, and then polarized, by means of which they acquire properties differing from those possessed by them before. The uniform results of all my experiments lead me to entertain no doubt that the magnetic carbide exercises first an attractive and then a polarizing power over oxygen, of a character analogous to that exercised by the magnet over the filings. That is to say, the oxygen which the carbide meets in the atmosphere, or in water, is first attracted to its surface, and, like the iron filings, its atoms become polarized; and, to complete the analogy, they acquire properties differing from those of oxygen in its ordinary state.
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> Thus, adds Mr. Spencer, I find this polarized oxygen to be identical with the body now known to chemists as ozone, and which is becoming generally recognised as one of Nature's chief agents of purification. That this is so, is not the result of mere speculation on my part; but, on the contrary, it is demonstrable by means of several conclusive experiments. The peculiar property possessed by ozone, or polarized oxygen, over ordinary oxygen, is its rapidity of combination with, and consequent neutralization of, every kind of noxious body having an organic origin.
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> As regards water, any noxious gaseous bodies that are found in it become instantaneously harmless on encountering the carbide in the process of filtration. This arises from their rapid combination with the ozonized oxygen they find on the surface of the carbide.

THE NEW METAL ALUMINIUM.

A PAPER on Aluminium has been read at the Society of Arts by Mr. Foster, the able Secretary of that Society. First mentioning the extension which chemical knowledge has undergone in modern times, and the boundless supply of aluminous substances which has thus been opened up—in granites, slates, schist, and especially in clays—the author pointed out the fact that aluminium forms an essential portion of our most brilliant gems, including corrundum, the sapphire, and the Oriental ruby and emerald ; and then proceeded to remark that, notwithstanding the universal diffusion of ores of aluminium, the existence of the metal itself was not known until the last half century, and its extraction has been attended by great difficulty. He then detailed the means adopted for producing sodium by Davy, Gay-Lussac, Thénard, Mitscherlich, Brunner, Donny, Mareska, and, more recently, Deville; and traced the labours of Oersted, Wöhler, and Deville, in the production of aluminium. After quoting from the paper read by the Rev. J. Barlow, in 1856, on Deville's process, noticing the modifications which Paul Morin introduced, and sketching the labours of Dr. Percy, Mr. Dick, and Rose (of Berlin), the author stated that Mr. Gerhard, an Englishman, had for some time past been endeavouring to introduce the manufacture into this country. The applicability of some of the alloys of this metal was then pointed out, as well as some of the difficulties which were for a time likely to retard its more general use, the most important being that hitherto no effectual solder had been discovered suitable for it. The valuable qualities it possessed—viz., extreme lightness, capability of resisting atmospheric action, malleability and ductility superior to those of silver, with a power of conducting electricity, and other important advantages, tended to show that though possibly its susceptibility to the action of moisture might render it unfit for some of the purposes to which, in the early stages of its discovery, it had been hoped to apply it ; yet that, if produced at a moderate price, it would be found a most valuable addition to our list of practically useful metals. The author drew attention to the advantages that it seemed to offer as a substitute for copper in the lower classes of coinage, for which it appeared in every way adapted when produced at a sufficiently low cost. The paper was illustrated by numerous specimens of ornaments, medals, and other objects made of this metal. A discussion ensued; in which Professor Tennant, Messrs. Elliott, Hawes, Laurence, May, Newton, Palmer, Smith, Strode, Thomson, the Chairman, and others took part.

A Correspondent of the *Mechanics' Magazine*, after reading Mr. Foster's lecture, forwarded to that journal a copy of a paper on Ammonio-iodides of Metals, read by the Rev. Mr. Reade, at the British Association in 1857. After the reading of this paper, Dr. Lee said :—"I would also observe that, with respect to the last metal alluded to in the paper—viz., Aluminium, Mr. Reade seems to have a particular object in not putting the solution of iodine in direct contact with the pure metal, as in the other examples. Here he takes an oxide of the metal, alumina, and by a new process attempts to solve the problem which has so extensively occupied the attention of practical chemists in extracting the pure metal from its compounds. Mr. Reade lives upon the great basin of Kimmeridge and Oxford clay in the Vale of Aylesbury. He is, therefore, really the owner of a fortune, lying, however, under his feet, but which only requires the wand of the chemist to transform it into pure metal and current specie."

M. Corbelli, a French chemist, has discovered a more simple and economical mode than that heretofore practised, for the extraction of Aluminium from clay. By his mode the metal is obtained directly from clay or argillaceous earth. The material is first washed free of all impurities and foreign matters, such as stones, leaves, morsels of wood, &c. Two or three ounces of it are then dried, and submitted to the action of acid, to get rid of the iron contained in it. For this purpose, M. Corbelli uses highly-concentrated sulphuric acid ; but nitric, hydrochloric, and other acids have the same effect. The earth is dissolved in six times its weight of acid, the earthy matters are allowed to subside, and the clear liquid is then poured off. The residue is dried, heated to 450° to 500° centigrade, and afterwards mixed with 200 grammes (between six and seven ounces English) of yellow prussiate of potass, well dried and pulverized—

the quantity of the latter being increased or diminished in proportion to the amount of silex contained in the clay. To this mixture are added about five ounces of sea-salt, and the whole is placed in a crucible and heated until a white colour is produced. After cooling, the aluminium is found at the bottom of the crucible.

As respects the *soldering* of this metal, until very lately quite imperfect results have been attained. In the Universal Exhibition of 1855, there were pieces of Aluminium soldered with zinc or with tin, but this weak solder did not give any solidity. Others have tried to solder with alloys of zinc, silver, and aluminium. Mr. Denis, of Nancy, has noticed that whenever aluminium and the solder melted over its surface was touched with a slip of zinc, the adhesion took place with great rapidity, as if a peculiar electric action gave it an impulse at the moment of contact; but this solder also has failed to afford much strength.

At last it has been suggested that the difficulty might be surmounted by previously coating the piece with copper, and then soldering together the coppered surfaces. In order to effect this, the aluminium, or at least the parts to be soldered, are plunged into a bath acid of sulphate of copper. The positive pole of the battery is put in direct communication with the bath, and the pieces to be coppered are touched with the negative pole; the deposit of copper takes place very regularly over the surface of the aluminium. These surfaces, thus prepared, are soldered in the ordinary way.

All these processes are, as is seen, very imperfect, and they now have only an historical interest, on account of a new and perfect method of soldering just discovered. The inventor is a gilder and silverer of metals, belonging to Paris, named Mourey; he has recently announced his process in a public meeting of the *Société d'Encouragement.*

The alloy employed is composed of zinc and aluminium. He adopts an ingenious device. In the ordinary way to solder two metals or two pieces of the same metal, all that is necessary after having prepared the two surfaces which are to be brought together, is to cover them with solder and to heat them. This mode of proceeding does not succeed with aluminium. M. Mourey prepares each of the two surfaces with a first solder, an alloy of aluminium and zinc, and then interposes between the two surfaces thus prepared another alloy richer in aluminium. In this manner the first alloy adheres to the aluminium itself, and the second alloy to the first, and thus a perfectly solid and continuous whole is obtained.

The surfaces to be soldered are prepared by being smeared with a mixture of turpentine, balsam of copaiva, and lemon juice, then placed on hot coals, and into the parts where the soldering is to take place, the flame of a gas lamp or self-acting blowpipe is directed.

Small pieces of an alloy of 6 parts of aluminium and 94 of zinc, are brought into contact with the prepared surfaces; these melt and adhere to the surfaces, being pressed against them by small tools made of aluminium. This operation [illegible] nd, a certain amount [illegible] In each case a skill and knack are necessary on the part of the workman, as well as care in adjusting the temperatures, for the melting points of aluminium and zinc are scarcely 100° apart, and there is a fear whilst melting the solder lest the article itself should melt at the same time.

When the two surfaces have been thus prepared they are brought together, and kept in contact by iron wires, pincers, &c., as in ordinary soldering; pieces of the hard solder (80 of zinc, 20 of aluminium) are then placed at the points of contact, and the heat from a lamp is then applied, and the second solder melts, runs in, and adheres to the two layers of soft solder, and thus forms a strong joint. The articles thus prepared are sufficiently strong and homogeneous to allow of their being re-worked, and the joints will bear filing.

M. Christofle has communicated to the French Academy of Sciences, in the form of a letter to M. Dumas, the result of some experiments made with Aluminium-bronze. He says:—

"We have applied the bronze of aluminium to two uses, for which its qualities of hardness and tenacity seemed specially fitted. The success has been quite equal to our expectations. The first is in the construction of bearing surfaces for rotating axles; the second for slide valves and other bearing surfaces exposed to much friction. Of these applications the following are examples:—The journals for the axle of a polishing wheel, making 2200 revolutions per minute, were made of aluminium bronze eighteen months ago; they have lasted to the present time. Other bearing surfaces under similar conditions do not last more than three months. Again, the slide bars of a sawing machine, the saw moving with the velocity of 240 revolutions per minute, were made of aluminium bronze. It has been used now one year without any apparent trace of wearing out. Slide bars of ordinary bronze would not, under similar circumstances, have lasted four months. The second application of the aluminium is for the manufacture of ordnance, gun-barrels, howitzers, and fire-arms. A pistol-barrel having been constructed of it in our manufactory, it was tried in the practice-ground of Renette, and was subsequently forwarded to the exhibition at Dijon. It was subjected there to every kind of test, in the presence of the jury; it bore them to the utmost of our expectations.

"We do not wish it to be imagined that this trial of a pistol-barrel can prove conclusively the value of the metal for ordnance, but the comparative experiments made by us between this metal, bronze, iron, and steel, have demonstrated its immense superiority over the others. So strong is our conviction on this point that we have requested the Academy to support our application to the Minister-at-War to be permitted, at our own expense, to make such a piece of artillery as may be thought most proper for testing the properties of aluminium bronze as a metal for guns. We look for great results in this direction, which we shall feel proud to associate with our name, at the same time rendering thanks to M. Saint Clair Deville, to whom is due the discovery of those alloys for which there appears so brilliant a future.

"The large bar deposited in the office of the Academy is intended to be forged and bored for a minié rifle. The small bar has already been forged, at a cherry heat, when it works like steel of the best quality, whilst it is well known that ordinary bronze is brittle when heated."

INHALATION OF CHLOROFORM.

A PAPER has been communicated to the French Academy of Medicine by Dr. Beraud, on the subject of Dr. Faure's method of administering Chloroform. This method consists in causing that agent to be inhaled by one nostril only, the other remaining meanwhile in free communication with atmospheric air. The apparatus is extremely simple, consisting of a bottle with two necks or tubulatures, and capable of containing 100 grammes of water. An india-rubber tube with a tapering end is adapted to one of the necks, and is intended for insertion into the nostril; the other neck remains open, the operator stopping it with his thumb when necessary. The tube is 17 centimetres in length, and has a diameter of at least 13 millimetres. To use this apparatus, pour about 10 or 12 grammes of chloroform into the bottle, and having stopped the open tubulature with your thumb, let the patient receive the tube into his nostril, recommending him to breathe naturally. There being no communication between the bottle and the atmosphere, the chloroform does not evaporate, and the patient is not aware of any unpleasant sensation. The subject having now acquired the habit of breathing in that way, the operator gradually slackens the pressure of his thumb, and allows a little air to enter, by which means the patient inhales atmospheric air charged with a little chloroform. From that moment, according as the painful sensation increases or diminishes, the outer air is alternately admitted or excluded, until the thumb being entirely withdrawn, the patient receives the full quantity required. The operation may also be conducted thus:—Let the patient breathe through the empty bottle, and then introduce a drop of chloroform, then another, and so on gradually. The great point is not to allow the effluvia of chloroform suddenly to exercise too irritating an influence upon the respiratory organs. After the second or third minute the operator should shake the bottle, so as to project the liquor on its sides, by which the evaporating surface is considerably increased. Should the patient happen to open his mouth the operator must close it with his hand. By this process the patient feels no pain, no sensation of suffocation or dyspnœa, nor is there any congestion of the brain. The state of anæsthesia may be continued with the greatest ease, and without danger, by keeping the tube ready to be again introduced into the nostril, if necessary; nor is there any possibility of sudden asphyxia, as the effects of the agent develope themselves very gradually.

LOCKJAW AND CURARE POISON.

Dr. Manec has sent to the French Academy of Sciences, the circumstantial account he had promised of his unsuccessful attempt to apply the Curare poison to the cure of Lockjaw. Dr. Vella, of Turin, first experimented with curare on a soldier whose wound had caused lockjaw. It was there shown that the tetanic spasms were regularly appeased by the introduction of curare into the system; nor did this occur once or twice, but during the whole period of the treatment, which lasted above a month. Dr. Vella's testimony is corroborated by his chief physician, Dr. Salleron. Here, on the other hand, Dr. Manec, aided by Dr. Vulpian, who has been for years engaged in experimenting upon curare, operated on a patient aged 39, suffering from a compound fracture of the shoulderblade. Symptoms of traumatic lockjaw appearing, Dr. Manec made an incision in the left arm, and introduced into the wound two drops of a solution of curare in the proportion of half a milligramme per drop. The dose was repeated 10 minutes later, but without any result. Another incision was made in the thorax, and the poison introduced in the proportion of half a centigramme per drop; this was repeated at intervals of from 10 to 7 minutes, still without the slightest success. At last a small bolus of 2¼ centigrammes of pure curare was introduced into the incision in the arm; then, the patient having been seized with a violent tetanic convulsion, five drops of a solution of 20 centigrammes of the poison in one gramme of water were introduced into the cellular tissue above the right shoulderbone; then, again, above the right one—and no alleviation at all was obtained, the patient dying at 10 p.m. on the next day. The operators imagining that their curare might be impure or spoilt, afterwards tried it on a dog, on which it produced its usual effect. We leave the profession to decide between two such opposite results, obtained by equally trustworthy practitioners under circumstances equally decisive and equally authenticated. Dr. Vella was, however, more fortunate in a third case, that of a sergeant, aged 35, who had been struck with a bullet in the right foot at the battle of Magenta, June 4: he recovered after six weeks' treatment. M. Velpeau cast some doubts on the sufficiency of the fact to establish the value of curare as a specific against tetanus, seeing that it is a most dangerous poison that requires to be handled with extreme caution. M. Claude Bernard remarked that the extraordinary tales related of curare contained much exaggeration, but that it could be safely introduced into therapeutics like prussic acid and other deadly poisons.—*Galignani's Messenger.*

NEW DISINFECTANT.

M. **BURDEL** has sent to the French Academy of Sciences, a communication on MM. Corne and Demeaux's Disinfecting Compound. M. Dumas having in a previous sitting remarked that if it be admitted that the emanations of tar ozonize the air, the above compound owed its efficacy to its prompt combustion of miasmatic effluvia by means of the ozonized oxygen it contains. M. Burdel has endeavoured to test the truth of this remark by experiment. In the cleansing of a canal a quantity of very fetid mud was thrown out, in the presence of which Schönbein's ozonometer revealed no trace of ozone. M. Burdel had this mud mixed up with a compound of marl and tar, when the fetid odour immediately disappeared, and the ozonometer marked seven degrees after the lapse of 12 hours.

NEW STOPPING FOR DECAYED TEETH.

M. **FEICHTINGER** communicates the following recipe to the *Repertoire de Pharmacie*:—Take of powdered glass 1 part, oxide of zinc 3 parts, and mix them intimately. The two substances must be in impalpable powder, and the latter must be free from carbonate of zinc. Then take of a solution of chloride of zinc (density 1·5 to 1·6) 50 parts, borax 1 part. Dissolve the borax in a little hot water, and pour it into the chloride of zinc; borate of zinc is precipitated, which disappears on agitating the mixture. To make the stopping, mix the powder with enough of the solution to form a stiff paste. Only so much as may be wanted at the time should be mixed, as the compound quickly hardens. In the course of a day it becomes as hard as marble, and remains so, even after prolonged contact with water. If the ingredients are pure, the stopping is perfectly white; but if it be required to match teeth of a yellowish colour, the necessary tint may be given by mixing a little ochre with the powder.—*Chemical News*, No. 1.

ANIMAL COMPOSITION.

THERE has been read to the Royal Society an elaborate "Experimental Inquiry into the Composition of some of the Animals fed and slaughtered as Human Food." By Mr. J. B. Lawes, F.R.S., F.C.S., and J. H. Gilbert, Ph.D., F.C.S.

After alluding to the importance of the chemical statistics of nutrition in relation to physiology, dietetics, and rural economy, and explaining that the branch of the subject comprehended in the present paper is that of Animal Composition, the authors proceed in the first place to state the general nature of their investigations, and the manner in which they were conducted. We have only space to quote a portion of the authors' conclusions:—

It would appear to be unquestionable that the influence, on the large scale, of the introduction of animal food to supplement our otherwise mainly farinaceous diet, is to reduce, and not to increase, the relation of the nitrogenous or peculiarly flesh-forming, to the non-nitrogenous constituents (reckoned in their respiratory and fat-forming capacity) of the food consumed..

That, nevertheless, a diet containing a due proportion of animal food is, for some reason or other, generally better adapted to meet the collective requirements of the human organism than an exclusively bread or other vegetable one, the testimony of common experience may be accepted as sufficient evidence. Whatever may prove to be the exact explanations of the benefits arising from a mixed animal and vegetable diet, it is at any rate pretty clear that, independently of any difference in the physical, and perhaps even chemical relations of the nitrogenous compounds, they are essentially connected with the amount, the condition, and the distribution of the fat, in the animal portions of the food.

Fat is the most concentrated respiratory, and of course fat-storing material also, which our food-stuffs supply. It cannot be doubted that, independently of the mere supply of constituents, the conditions of concentration, of digestibility, and of assimilability, of our different foods, must have their share in determining the relative values, for the varying exigences of the system, of substances which, in a more general, or more purely chemical sense, may still justly be looked upon as mutually replaceable.

By the aid of chemistry, it may be established, that, in the admixture of animal food with bread, the relation (in respiratory and fat-forming capacity) of the non-flesh-forming to the flesh-forming substances will be increased; and further, that in such a mixed diet, the proportion of the non-flesh-forming constituents, which will be in the concentrated form, so to speak, of fat itself, will be considerably greater than in bread alone. Common experience also testifies to the fact of advantages so derived. It remains to physiology to lend her aid to the full explanation of that which chemistry and common usage have thus determined.

ANIMAL FOOD AND BREAD.

DR. GILBERT has read to the Chemical Society a paper "On the composition of the Animal portion of our Food, and on its relations to Bread." The general conclusions were, that only a small proportion of the increase of a fattening animal was composed of nitrogenous matter; that from five to ten per cent. only of the nitrogenous matter of the food was stored up in the body of the animal; but that the amount of fat stored up was frequently greater than the amount supplied in the food, despite the loss incurred in the maintenance of the respiratory function. Hence the comparative values of fattening foods were proportional rather to the amounts of respiratory than of assumed flesh-forming constituents. It was calculated that in those portions of the carcases of oxen actually consumed as human food, the amount of dry fat was from two to three times as great as the amount of dry nitrogenous matter; and in the eaten portions of the carcases of sheep and pigs, more than four times as great. By substituting for the above proportions of fat, their respiratory equivalents in starch, so as to allow of a comparison between meat and bread, the ratios become 6 or 7 to 1, and 11 to 1 respectively. From the independent determinations of Messrs. Lawes and Gilbert, Dr. F. Watson, and Dr. Adling, it appeared that in wheat bread the ratio of starchy to nitrogenous matter was as 6 or 7 to 1, so that in bread the proportion of assumed flesh-forming constituents to respiratory constituents, was greater than in the eaten portions of sheep and pigs, and quite equal to that of the eaten portions of oxen, a conclusion altogether opposed to the prevalent notions on the subject.

TRANSFORMATION OF WOODY FIBRE INTO SUGAR.

Pelouze has announced the important results which follow. Cellulose precipitated from its solution in ammoniacal oxide of copper by a feeble acid is soluble in dilute chlorohydric acid. Ordinary cellulose is soluble in concentrated chlorohydric acid; water forms with this solution a precipitate of dazzling whiteness; at the end of two days the precipitate ceases to form, and all the cellulose has been transformed into sugar affording the characteristics of glucose,

The transformation of cellulose into glucose can be effected by a prolonged ebullition in water containing a small quantity of sulphuric or chlorohydric acid (some hundredths); paper, old linen, sawdust, and any cellulose more or less pure, can be thus turned into sugar at the end of several hours' boiling.

Pelouze thinks that this reaction will become the basis of a new branch of industry—one which has often been attempted since Braconnot succeeded in 1819 in transforming lignine into glucose; he thinks that the transformation would be rendered much more active by operating in a close vessel at an elevated temperature.

Lastly, Pelouze announces that, by treating cellulose with caustic potassa in fusion at a temperature between 150° and 190° C., and dissolving the product in water, a substance can be separated from it by acids which has the composition of cellulose, but differs from it in that it is soluble in the cold in alkalies; it changes into sugar in the presence of chlorohydric acid.—*Silliman's American Journal of Science and Arts* for July, 1859.

DETECTION OF METALLIC POISONS IN MEDICO-LEGAL INQUIRIES.

In Liebig and Kopp's *Annual Report* for 1850, English edition, page 409, a process is given by Gaultier de Claubry for the Detection of Metallic Poisons in organic mixtures by their electrolytic decomposition. The method is stated to be conveniently applied in judicial analyses. Has any instance been recorded of the employment of such a system? And what form will antimony and arsenic assume? Will they escape as gaseous hydrogen compounds, or be deposited as reduced metal on the negative plate?—*Chemical News*, No. 1.

REINSCH'S TEST FOR ARSENIC.

In experimenting on different solutions of the Salts of Arsenic by Reinsch's test, it is very important to know that there is a considerable difference in point of time before the copper wire becomes coated with arsenic. The arsenites show it almost the instant the liquid boils; whereas the arseniates, or more highly oxidized salts, require a longer time and greater degree of concentration before any deposit is obtained. A knowledge of this fact may prevent an erroneous conclusion being drawn as to the presence of arsenic, although it may not be immediately detected.

In combination with chlorates, as proved by Dr. Taylor in Smethurst's case, no deposit is obtained, the arsenic remaining in solution; whilst the copper is dissolved, and imparts a blue colour to the liquid.

The *delicacy* of Reinsch's test has been greatly *underrated* by Taylor, Brande, and others, who state that arsenic fails to be detected when diluted to 120,000 times its bulk. How such a mistake should occur I cannot imagine; since, in accurate experiments lately made by me, I have detected it at a dilution of 560,000 times; and when at 280,000 times, the layer is so strong as to be fit for sublimation, having a bright steel colour: at 560,000 times, however, the deposit is more of a violet colour. These experiments were made by dissolving a grain of arsenious acid in a pint of distilled water, and diluting from time to time.

Compared with arsenic no deposit of antimony from a solution of tartar emetic took place at either of these points of dilution.—*Chemical News*, No. 1.

MARSH'S TEST FOR ARSENIC.

Dr. Odling, in a paper read by him to the British Association, has shown that numerous and varied bodies, including the organic substance contained in ordinary vegetable tissue, animal tissue, salts of copper, and oxidizing salts, prevented the formation of arseniated hydrogen, and thereby defeated the action of Marsh's test. As a mode of separating the arsenic from these interfering substances, the author recommended the process of distillation with muriatic acid, whereby arsenic in form of trichloride of arsenic is isolated in a form suitable for testing.

A remark made by Mr. Trevelyan during the late meeting of the British Association at Aberdeen, that it was the opinion of some that arsenic, when taken in small quantities, was not deleterious to the system—brought forth a warning from Dr. Daubeny and the

President, not to put any faith in the statement in Dr. Johnston's *Chemistry of Common Life*, that arsenic is taken by the girls of Tyrol to improve their complexion, and that when taken constantly the system becomes used to it, that being the reverse of the fact. Mr. Liveing observed that he had heard that this use of arsenic had been told to Dr. Johnston by a practical joker, who did not like to confess his imposition after it had been made public.

ARSENICAL FLY-PAPERS.

Mr. Harry N. Draper has communicated to the *Pharmaceutical Journal*, No. 5, the following paper:—

While criminal poisoning with arsenic is a matter of so frequent occurrence, all facts which tend to lessen the difficulty of convicting the prisoner are of the highest importance. A medical jurist appointed to investigate such a case would, in all probability, little think of seeking the source of the poison in a fly-paper.

Fly-papers are sold by the thousand; there is scarcely a house without them; they are positively stated to be perfectly harmless to animal life of a higher order than that of our insect pests. That such is, however, far from being the case, the following results of an examination of them will show. The papers selected for examination as being those most generally employed, were those known as "Papier Moure."

Four of the sheets were taken at random and digested with dilute hydrochloric acid until a pulpy mass was obtained. This pulp was then placed on a filter and washed with distilled water until the filtered fluid amounted to about four pints. This was next evaporated until only eight ounces remained, and sulphide of hydrogen was passed into it for two hours. During this time a copious precipitate of sulphide of arsenic was thrown down, and the beaker containing the fluid was therefore set aside in a warm place to ensure its complete separation. The precipitate was collected on a filter, washed, and dissolved in dilute solution of ammonia, from which it was re-precipitated by hydrochloric acid. The pure sulphide of arsenic was finally collected upon a tared filter, dried, and weighed. Its weight was found to be 12·675 grains, equivalent to 10·201 grains of arsenious acid. The average quantity of arsenious acid contained in each of the sheets was therefore 2·55 grains, quite enough to destroy a human life.

Is it not rather an evidence of faulty legislature, that while restrictions are placed upon the sale of arsenic *as* arsenic, the poison should be so readily obtainable in the form of "Papier Moure?"

It may not be uninteresting to mention that the presence of arsenic in a fly-paper may be very readily detected by moistening a strip of the paper with a solution of an alkaline acetate, drying by the fire and igniting. As the paper smoulders away the unmistakeable odour of *alkarsin* affords ample evidence of the poison.

In the filtrate from the sulphide of arsenic I found iron and lime, derived, of course, from the tissue of the paper itself, and on evaporation, a dark-coloured extractive matter, which, owing to its taste being much modified by the chloride of ammonium formed in the course of the analysis, I was unable to identify. There was also a considerable quantity of potash, which had doubtless served the purpose of dissolving the arsenious acid.

"ARSENIC NOT INJURIOUS TO LARVÆ OF FLIES."

A PAPER with this title, by Mr. Storer, of Boston, U. S., has appeared in *Silliman's Journal*, in which it is stated that within forty-eight hours the bodies of some rats which had been poisoned with arsenic were thoroughly flyblown and covered with a multitude of larvæ. These, after consuming all the flesh of the rats, concealed themselves in sheltered corners, and in due course were converted into chrysalids. This is remarkable, as it is well known that flies themselves are quickly destroyed by arsenic.

ARSENIC IN GREEN PAPER-HANGINGS.

As this subject continues to excite a good deal of attention, we give a simple method by which the presence of Arsenic may be immediately recognised, and, if necessary, the quantity determined. Immerse a measured piece of the paper, say two square inches, in strong ammonia. If a blue colour be communicated to the ammonia, the presence of arsenic may be suspected. For a proof, remove the paper, and drop into the test glass a small crystal of nitrate of silver, which, if arsenic be present, will quickly become covered with a yellow coating, which will disappear on stirring the liquid. If now it is wished to estimate the amount of arsenic, immerse the paper again in fresh ammonia until the liquid is no longer coloured blue, then evaporate all the solutions to dryness. Mix the residue with three times its weight of black flux, or carbonate of soda, and sublime in a glass tube; then cut off the end of the tube, dissolve the sublimate in hydrochloric acid, and precipitate with sulphuretted hydrogen; collect the precipitate on a weighed filter, wash well, dry, and weigh. Each grain of the precipitate corresponds to 0·8 of a grain of white arsenic.—*Chemical News*, No. 1.

ARSENIC IN ARTIFICIAL MANURES.

PROFESSOR DAVY has read to the Royal Dublin Society a paper "On the presence of Arsenic in some Artificial Manures, and its absorption by Plants grown with such Manures."

It is well known to chemists that sulphuric acid or oil of vitriol, as it is met with in commerce, almost always contains variable proportions of arsenic; but it appears to me that this fact has been overlooked by the public, and that they are not aware to what extent this highly poisonous substance occurs in general in commercial sulphuric acid, and thus becomes the means by which arsenic enters the different substances in whose preparation that acid is employed.

We have not space for the details of the experiments, but give the author's conclusions:—

These experiments appear to me to be perfectly conclusive as to the power possessed, by some plants at least, of taking up arsenic when it is introduced into the soil by artificial manures which contain it, even when they are employed in the usual way and proportions by agriculturists, and how objectionable it is to use any materials in the preparation of those manures which will introduce so destructive and dangerous a substance as arsenic into the soil.

I thought it would be desirable to ascertain the proportion of arsenic present in the brown sulphuric acid used by one of our Dublin manufacturers for the purpose of making superphosphate and other manures. In 12 fluid ounces of the acid, by the usual methods of determining the quantity of arsenic in such cases, I obtained an amount of metallic arsenic equivalent to about 12 grains of arsenious acid, or 1 grain to each fluid ounce; and the ounce of acid weighing about 800 grains, the arsenious acid would be $\frac{1}{800}$th part of the weight of the acid, which would be equivalent to about 2·8 lbs., or nearly 3 lbs. weight in the ton of sulphuric acid. But it is probable that the generality of brown sulphuric acid employed contains much more arsenic than this sample I examined, its specific gravity being about 1·780, whereas the usual strength of the acid is 1·845. Dr. Owen Rees found 13·5 grains of arsenious acid in 12 fluid ounces of commercial sulphuric acid; and Mr. Watson, in the *London Medical Gazette*, states that the smallest quantity of arsenious acid which he detected in the same amount of commercial acid was 21·3 grains. There is therefore every reason to suppose that the acid usually employed for agricultural purposes contains a far greater quantity of arsenic than the sample I examined; and as the proportion of sulphuric acid used in making these artificial manures is very large (thus, for example, in the manufacture of superphosphates, the most valuable manure of this class, about one ton of acid is used for every two tons of bones employed), the quantity of arsenic present in such manures must be considerable.

These facts appear to me to have some important bearings; for though the quantity of arsenic which occurs in such manures is not large when compared with their other constituents, and the proportion of that substance which is thus added to the soil must be small, still plants may during their growth, as in the case of the alkaline and earthy salts, take up a considerable quantity of this substance, though its proportion in the soil may be but very small. Further, as arsenic is well known to be an accumulative poison, by the continued use of vegetables containing even a minute proportion of arsenic, that substance may collect in the system till its amount may exercise an injurious effect on the health of man and animals.

As connected with this subject, I may observe that I was informed of a curious fact,—that sheep did not appear to like Mr. Rathbone's turnips, which were grown with superphosphate, so well as those where the ordinary farm-yard manure had been employed, and that they could not be made to eat enough of the former turnips to fatten them properly. If this was really the case, it would appear to favour in some degree my views as to the probable unwholesomeness of vegetables grown with manures containing even in small quantities so deadly a poison as arsenic, which my experiments have shown that plants are capable of taking up from such manures.

Finally, these investigations appear to have a medico-legal bearing; for in cases of suspected poisoning by arsenic, where the evidence may chiefly depend on the detection of a small quantity of that substance in the liver and other viscera, as is sometimes the case, my experiments would tend to throw much doubt and uncertainty on such cases, because the presence of a minute quantity of arsenic in the viscera may not be owing to its direct administration, but to its having found its way into the system through the vegetable and, indirectly, animal food taken by the individual.

These and other important considerations connected with this subject can only be determined by a series of carefully conducted experiments, which I purpose commencing, and I hope at some future time to have the pleasure of communicating their results to this Society.

THE ADULTERATION OF FRENCH WINES BY PLASTER

Has long been permitted under certain regulations. It is now strongly protested against by three eminent French chemists, MM. Bouchardat, Payen, and Barral, in a report on the subject. Another chemist, M. Poggiale, says:—"The addition of plaster to wine causes the disappearance of the most useful salts, the bitartrate and phosphate of potash, and the phosphates of lime and magnesia, and replaces them by principles which we ought to consider injurious to the human organism, since they are not found in the blood or other animal fluids."—*Répertoire de Chimie.*

LEAD IN SNUFF.

It has long been known that Snuff contains Lead when it has been kept in vessels made of that metal. A commission of German chemists have determined, after long research, that snuff wrapped in lead, even when covered with paper, or combined with tin, gradually becomes poisonous by acting upon and taking up the metal. They recommend snuff to be kept in paper, coated with wax, gutta percha, or some resinous substance.—*Journal de Pharmacie.*

COAGULATION OF THE BLOOD.

Dr. Davy, F.R.S., has communicated to the Royal Society of Edinburgh the following paper:—

Dr. Richardson, in a recent and elaborate work on the Blood, an extension of a Prize Essay on the cause of the Coagulation of this fluid, has endeavoured to prove that this phenomenon is of a chemical kind, depending on the escape of the volatile alkali.

Dr. Davy describes three sets of experiments, which he has instituted for the purpose of testing Dr. Richardson's hypothesis. In all his trials on blood, he has used that of the common fowl, its properties being best adapted to the objects in view. The results obtained were briefly the following:—

1. Ammonia added to the blood in small quantities did not prevent its coagulation; in larger quantities it retarded coagulation, and rendered the blood viscid.
2. On exposing mixtures of blood and ammonia, and of water and ammonia, to the open air, the loss of weight sustained in two or three minutes—the time required for the coagulation of the blood—was hardly appreciable, using a very delicate balance.
3. The moist fibrin of the blood subjected to the action of ammonia was found to be rendered transparent and viscid, but to be very slightly soluble.

These results, and others, such as the coagulation of the blood in close vessels, and the volatile alkali not having hitherto been detected in healthy blood, have led the author to the conclusion that the phenomenon under consideration still remains an unsolved problem; and that on the ground of mere probabilities it is not easy to say which of the two chief hypotheses advanced concerning it—the chemical and the vital—is deserving of preference.

RED DYES.

Mr. Brooman has patented an improvement in the preparation of Red Dyes. The inventor boils for fifteen or twenty minutes a mixture of aniline and anhydrous bichloride of tin. At first the mixture assumes a yellow, then a reddish tint, and finally changes to a beautiful red. The mixture is liquid while hot, but when cold becomes gelatinous. The gelatinous mass is boiled with water, and filtered hot; and the colouring matter is precipitated from the filtered liquor as it cools. To completely separate this colouring matter, the patentee dissolves in the liquor either a tartrate, acetate, an alkaline or earthy chloride, an alkaline phosphate or pyrophosphate, or chloride of mercury, which precipitates the whole of the colouring matter. For dyeing, either the solution obtained by boiling the mixture in water, or the solid colour dissolved in water is used. The usual mordants, except the mineral acids, may be used with it. To obtain a solution sufficiently strong to print with, the mixture of aniline and bichloride of tin is treated while hot with acetic acid, alcohol, or wood spirit, and the colouring matter is precipitated as before described. Another red dye is produced by mixing with aniline bichloride of mercury, perchloride of iron, or protochloride of copper, and treating this mixture as the former. The inventor gives the name of Fuchsiacine to these colours, from their resemblance to that of the fuchsia.

MADDER.

THE colouring properties of this invaluable dyestuff, prepared from the root of the Rubia Tinctorum, is the subject of a long and interesting paper by Dr. Edward Schunk, F.R.S., in a late number of the *Journal of the Chemical Society*. Madder attained its eminent position in dyeing without the aid of scientific chemists, and it is only lately that their attention has been directed to it. Since they have done so, however, various interesting discoveries have been made—viz., Alizarine and Purpurine, and, in consequence, Garancine, by Robiquet, Colin, Persoz. and others; and Xanthine by Kuhlmann. To these Dr. Schunk has added Rubian, Verantine, and compounds from them. He gives, in conclusion, the results of his researches in a tabular form at the end of the paper. To it is subjoined an account of the optical characters of Purpurine and Alizarine, with an illustration, by Professor G. G. Stokes.

NEW GREEN COLOUR.

DR. CRACE CALVERT has presented to the Manchester Literary and Philosophical Society, in the name of Mr. Arnaudon (from Turin), a paper, and samples of Green Colours used in painting and printing, and especially referred to two new chrome greens, one of which is a new compound, corresponding to the monohydrate of sesquioxide of chrome $Cr^2 O^3 HO$. The author commences in his work to point out the qualities which a good green ought to possess, in order to be suitable for painting. Then he reviews in a few words the different greens which are found at present in the market, together with the nature and properties of the same. Beginning with the history of the works already published on this subject, he next gives the description of his process for preparing his monohydrate of sesquioxide of chrome, and which consists in exposing the bichromate of potash mixed with phosphoric acid and any desoxydizing agent (for example, ammonia), for some time to the action of heat. The soluble salts are then removed by washing.

The green so prepared has not only a beautiful shade, but, like that of Mr. Guignet (made by decomposing the borate of oxide of chrome by water), possesses the curious property of remaining green under the influence of artificial light. Dr. Calvert also presented some muslins printed by M. Camille Kæchlin, of Mulhouse, with fuchsine, a product obtained from the aniline of coal tar.

This colour was very remarkable from the exquisite bloom of the pink shade obtained when fixed with albumen.

MAUVE DYE.

THE *Art Journal* states that the exquisitely beautiful Dye for silks, the *Mauve*, is prepared by taking equivalent proportions of sulphate of aniline and bichromate of potash, dissolving them in water, mixing, and allowing them to stand for several hours. The whole is then thrown upon a filter, and the black precipitate which has formed is washed and dried. This black substance is then digested in coal-tar naphtha, to extract a brown, resinous substance; and finally digested with alcohol, to dissolve out the colouring matter, which is left behind, on distilling off the spirit, as a coppery friable mass. This is the dyeing agent producing all the charming varieties of purples known by the name *mauve*, which, as it appears to us somewhat inappropriately, has been given to this colour. The particularity of these purples consists in the peculiar blending of the red and blue of which they are constituted. These hues admit of almost infinite variation; consequently, we may have many varieties of *red mauve*, and as many of *blue mauve*, and any depth of tint can be secured. The permanence of these hitherto fugitive combinations is their strongest recommendation.

NEW BLACK DYE.

A PARIS Correspondent of the *Critic* says that the New Black Dye which has just been discovered in Algeria is the great object of interest amongst chemists and manufacturers just at this moment. The discovery has been made by M. Muratere, and is a vegetable substance gathered from a tree which grows in immense profusion all over the colony. It is destined, according to the report made upon its merits, to replace every other substance in use for the same purpose up to this day, and is more brilliant than any dye hitherto known. The discoverer has registered his patent for its use under the name of "Algerian Campeachy wood." It would appear that M. Muratere intended to have reserved the publicity of his new dye till the Exposition of 1860; but upon the publication of the Minister's circular letter announcing that no exposition will take place, as had been anticipated, he has determined on making the advantages of his discovery known at once. As no reason is given in the Minister's letter for not holding the exhibition, and no term fixed for the reparation of its omission in 1859, of course gossiping tongues are not idle in ascribing all kinds of ill-natured suppositions to the measure. A company of weavers, dyers, embroiderers, and designers is reported to have arrived at Bordeaux from Cashmere, for the purpose of forming an establishment in the neighbourhood of Paris for the manufacture of "real" Cashmere shawls. The idea is said to have originated with the Emperor himself, who, disgusted with the length of time which has been occupied in making the famous green shawl for the Empress, ordered by his Majesty more than five years ago, suggested to an enterprising shawl merchant of Marseilles the facility of procuring native workmen, who, under the vigilant eyes of Europeans, would be taught to work with activity.

GILDING TEXTILE FABRICS.

M. **BUROT** has discovered a method of Gilding Stuffs by means of electrical agency. The piece to be gilt is dipped into a solution of nitrate of silver and ammonia; after remaining in this for two hours, it is taken out, and, when dry, exposed to a current of pure hydrogen gas, which reduces the salt, and leaves the silver in a metallic state on the stuff. A silvered surface is thus obtained, which is easily gilt over by the usual galvanoplastic methods.—*Critic.*

SOLIDIFICATION OF OILS.

M. **PERRA**, in a paper addressed to the French Academy of Sciences, has described a method for transforming Vegetable Oils into Solid Masses, through the action of chloride of sulphur. This substance, when composed so as to contain the largest proportion possible of sulphur, is poured in the oil at the common temperature; the mixture is well stirred and allowed to stand. By degrees it becomes warm, and the solidification takes place. The operation must be performed on small quantities at a time, in order to avoid the generation of too high a temperature, which would drive off the chloride by evaporation, and perhaps even carbonise the oil. As soon as the combination is effected, the mass is poured out on a plate of glass, carefully flattened, and then left to cool; at the end of five or six minutes it becomes hard. A second stratum may then be cast on the former, and so on until the requisite thickness has been obtained. Care must be taken, however, to prevent the interposition of moisture between the layers, otherwise they will not join. One hundred parts of linseed oil and twenty-five parts of chloride of sulphur will produce the greatest hardness possible; if the proportion of chloride be reduced to twenty or fifteen parts, the mass will be supple, like india-rubber; and 100 parts of oil with only five of chloride will thicken the oil considerably without hardening it. In this state it is soluble in all the usual mediums, such as oil of turpentine for example, which dissolve common oils. If a certain quantity of linseed oil be diluted with thirty or forty times its weight of sulphuret of carbon, and with one-fourth of its weight of chloride of sulphur, a liquid will be obtained which will not dry for some days. If this combination be laid with a brush on glass, wood, &c., the sulphuret of carbon will immediately evaporate, and the residue will become a varnish. We may state that some of these facts are not entirely new: in 1849, Professor Niclès, of the faculty of Nancy, announced the solidification of oil by the chloride of sulphur; and in the same year M. Rochelder observed it, and published an account of it in *Dingler's Polytechnic Journal*.—*Critic.*

REMARKABLE SOLVENT.

IT is now discovered, it appears, that if a piece of copper be dissolved in ammonia a solvent will be obtained, not only for lignine, the most important principle of all woody fibre, such as cotton, flax, paper, &c., but also for substances derived from the animal kingdom, such as wool and silk. By the solution of any one of these, an excellent cement and waterproofer is said to be formed; and, what is equally important, if cotton fabrics be saturated with the solution of wool, they will be enabled to take the dyes—such as the lac dye and cochineal—hitherto suited to woollen goods only. Hydriodide of ammonia, we may also observe, was not long since discovered to be an equally remarkable solvent of the most refractory, or at least insoluble, mineral substances. Now it is an interesting circumstance that ammonia, according to Van Helmont, and other old chymists and alchymists, was one of the requisite materials in the formation of the "alkahest," or "universal solvent," of the ancient sages! In the cupride of ammonium (if we may so call the solvent here first spoken of), we seem to have the solvent of silk which we lately desiderated in our remarks on the insulation of submarine telegraphic wires.—*Builder.*

MANUFACTURE OF KELP.

A PAPER has been read to the British Association "On Proposed Improvements in the Manufacture of Kelp," by Dr. Wallace. The chief defects of the present system were pointed out, and, by way of remedy, it was proposed that sheds should be erected for the desiccation of the weeds and their preservation from rain, and that the weeds should be burned or charred at a low temperature into a loose ash, instead of being strongly ignited and subjected to fusion as now practised. By this process the loss of iodine that appears at present to occur, and the production of sulphur compound, which cause an enormous consumption of vitriol in their decomposition, would be entirely avoided. Dr. Wallace described the varieties of weeds used by the kelpers, and the results of a series of experiments, conducted with the object of estimating the quantities of iodine and potash in the ashes of the various weeds when prepared by the improved process. From these it appeared that the ashes of the deep-sea tangle contained 28 lb., that of the black wreck, 9 lb., and that of the yellow or bladder wreck, 6 lb. of iodine per ton of 22½ cwt. Dr. Wallace concluded by calling upon the proprietors of the kelp-bearing shores to interest themselves more than they have hitherto done in this important manufacture, and to expend some capital in the erection of sheds, and purchase of such simple apparatus as the islanders are capable of using with advantage. By doing so, they would confer an important benefit upon their poor tenants, and insure greatly augmented returns from their estates.

CARBON INK.

MR. JOHN SPILLER, F.C.S., of the War Department, has communicated to the *Chemical News*,* No. 1, a paper on the employment of Carbon as a means of Permanent Record. The imperishable nature of carbon, in its various forms of lamp black, ivory black, wood charcoal, and graphite or black lead, holds out much greater promise of being usefully employed in the manufacture of a permanent writing material; since, for this substance, in its elementary condition, and at ordinary temperatures, there exists no solvent nor chemical reagent capable of effecting its alteration.

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* *The Chemical News, with which is incorporated the Chemical Gazette,* under the able editorship of Mr. William Crookes. This journal comprises the sections of Scientific and Analytical Chemistry, Technical Chemistry, Pharmacy, and Toxicology, Chemical Notes, and Laboratory Memoranda; it is ably edited.

The suggestion relative to the mode of applying carbon to these purposes, which it is intended more particularly now to enunciate, depends on the fact of the separation of carbon from organic compounds, rich in that element, sugar, gum, &c., by the combined operation of heat and of chemical reagents, such as sulphuric and phosphoric acids, which exert a decomposing action in the same direction; and by such means to effect the deposition of the carbon within the pores of the paper by a process of development to be performed after the fluid writing ink has been to a certain extent absorbed into its substance. A system of formation by which a considerable amount of resistance, both to chemical and external influences, appears to be secured. An ink of the following composition has been made the subject of experiment:—

Concentrated sulphuric acid, deeply coloured with indigo	1 fluid ounce.
Water	6 ,, ,,
Loaf sugar	1 ounce troy.
Strong mucilage of gum arabic	2 to 3 fluid ounces.

Writing traced with a quill or gold pen dipped in this ink dries to a pale blue colour, but if now a heated iron be passed over its surface, or the page of manuscript held near a fire, the writing will quickly assume a jet black appearance, resulting from the carbonisation of the sugar by the warm acid, and will have become so firmly engrafted into the substance of the paper as to oppose considerable difficulty to its removal or erasure by the knife. On account of the depth to which the written characters usually penetrate, the sheets of paper selected for use should be of the thickest make, and good white cartridge paper, or that known as "cream laid," preferred to such as are coloured blue with ultramarine, for in the latter case a bleached halo is frequently perceptible around the outline of the letters, indicating the partial destruction of the colouring matter by the lateral action of the acid.

The writing produced in this manner seems indelible; it resists the action of "salts of lemon," and of oxalic, tartaric, and diluted hydrochloric acids—agents which render nearly illegible the traces of ordinary black writing ink; neither do alkaline solutions exert any appreciable action on the carbon ink. This material possesses, therefore, many advantageous qualities which would recommend its adoption in cases where the question of permanence is of paramount importance; but it must, on the other hand, be allowed that such an ink, in its present form, would but inefficiently fulfil many of the requirements necessary to bring it into common use. The peculiar method of development rendering the application of heat imperative, and that of a temperature somewhat above the boiling point of water, together with the circumstance that it will be found impossible with a thin sheet of paper to write on both sides, must certainly be counted among its more prominent disadvantages.

Though not perhaps capable of employment on the animal tissues, vellum and parchment, there is every probability of its successful application in connexion with the new material produced by the action of strong acids on paper, and known under the name of vegetable parchment.

LUBRICATING CARTRIDGES.

DR. SCOFFERN has patented a composition for lubricating cartridges. He uses a mixture of equal weights of paraffine and naphthaline, preferring, however, a compound made by melting india-rubber in an open vessel over a fire, and thoroughly mixing with it four times its weight of paraffine, and one-half its weight of naphthaline. The mixture when wanted for use is melted in an oil bath, and the temperature is kept as near 240° as possible. The advantage of the compound is said to lie in the fact that it is volatilised without change on the application of heat.

BLAZE-PROOF DRESSES.

THE frequent melancholy accidents of ladies' dresses taking fire teach a lesson which must not be neglected. The light fabrics manufactured for ladies' dresses should be made blaze-proof. Nothing can be more simple. The most delicate white cambric handkerchief, or fleecy gauze, or the finest lace, may, by simply soaking in a weak solution of chloride of zinc, be so protected from blaze that if held in the flame of a candle they may be reduced to tinder without blazing. Dresses so prepared might be burnt by accident without the other garments worn by the lady being injured. The dresses of stage dancers are prepared in the way we recommend. Why are dancing ladies of rank to be exposed to danger from which their dancing sisters by profession are protected?

A valuable discovery has been made by Messrs. Versmann and Oppenheim, of 7, Bury-court, St. Mary-axe, and was the subject of a paper lately read before the British Association. It is that sulphate of ammonia and tungstate of soda have the property of making linen and cotton fabrics uninflammable, and do not injure or discolour them in washing.

In the conversation which ensued, Mr. Grahame stated that the investigation of this subject had been at first set about at the wish of Her Majesty, who longed to see some mode discovered by which light dresses might be less liable than at present to endanger the lives of their owners through catching fire. Preparations of these salts are used in the Royal laundry; and their general adoption would prevent a vast number of those dreadful accidents which now almost daily occur to children and others. To this we have to add that MM. Doebereiner and Alsner, after discussing the merits of borax, alum, and soluble glass, for diminishing the combustibility of cotton tissues, recommend phosphate of ammonia, which is cheap, and can be easily combined with sal ammoniac, and introduced into the starch with which the tissues are prepared.—*Répertoire de Chimie.*

PHOTOGRAPHIC PROGRESS.

The following are a few of the striking results of the past year:—

Carbon Printing.—At the meeting of the Photographic Society, January 4, 1859, Mr. Pouncey, of Dorchester, read a paper on his process of Carbon Printing, which has excited so much interest and curiosity. The paper is published at length, with Mr. Pouncey's subsequent explanations, in the *Photographic Journal* of January 8. Referring to that for all details, we may state generally that Mr. Pouncey's method consists in preparing the paper for printing on, by spreading over it by means of a hog's-hair brush a mixture of finely powdered vegetable carbon, and equal parts of a saturated solution of bichromate of potash, and a common solution of gum arabic; the proportions being one drachm of the carbon to four drachms of each of the solutions. After it is dry the paper is ready for printing on by exposure in a printing-frame in the usual manner—the time of exposure being from four to five minutes in the sun, and from ten to fifteen in the shade, but varying according to season, character of negative, &c. In washing the picture, it must lie under water for at least five or six hours, when the pictures, of which previously scarcely a trace was perceptible, will become visible. The principal difference in the appearance between a carbon print and one prepared with silver being, according to Mr. Pouncey, "that one may probably fade, while the other remains imperishable."

Discovery of a new action of light, and that light could be stored up, as it were, for use whenever required.—M. Nièpce having invited Mr. Wheatstone to visit his laboratory in the Louvre, and "see with his own eyes a photograph made by light which had been stored up for several months," the *Photographic News* of Feb. 18 contains a communication from the Abbé Moigno, giving full particulars of the result:—

> "M. Nièpce took a tube containing a piece of pasteboard which had been impregnated with tartaric acid, insolated for a length of time, and rolled up in it, in the month of June last, and the tube then hermetically closed. He and Professor Wheatstone placed themselves in a dark room; M. Nièpce had a sheet of sensitized paper, on which he placed a piece of paper printed upon in large letters; he then opened the tube, holding it vertically, with the orifice downwards, and this orifice he placed on the printed paper which covered the sensitive paper; the tube was left in this position for about ten minutes, at the end of which time he removed it. The circle on the paper blackening in all its parts where it was not protected by the printed letters, at once visibly manifested the action of the light; the printed paper being removed, the characters were found to be very neatly traced in white, or forming a negative proof; this negative was treated like ordinary negatives, that is to say, it was fixed, and Professor Wheatstone placed it in his portfolio, to produce it before the Royal and Photographic Societies; a proof obtained by means of light that had been imprisoned for six months. The experiment, therefore, succeeded perfectly. Professor Wheatstone takes with him two tubes, one of which was placed in our hands on the 7th February, 1858, more than a year ago, the other closed in the month of June last, like that which was so efficacious under his inspection, and he will himself repeat the experiment in London before his illustrious colleagues, who will not then retain even the shadow of a doubt as to the reality of the persistent activity of the light."

M. Moigno gives in the paper referred to a formula by which "every one who wishes may succeed" in obtaining similar results.

The editor of the *Photographic News* has seen the picture taken in the presence of Professor Wheatstone, and states that—

> "The distinctness with which the printed paper used as a negative is reproduced on the sensitized paper, is perfectly surprising."

The same paper also contains an account of another remarkable discovery recently made by M. Nièpce :—

> "Having prepared a paper with nitrate of silver and chloride of gold, he placed a negative upon it and enclosed the whole in a substitute for the ordinary printing frame, and submitted it to the action of *radiant heat;* the result answered his expectations. We have before us pictures obtained by him by these means, which are very distinct, even to the extent of reproducing legibly the inscription around a shield."

This result is probably due to molecular action ; and indeed some very curious results, pointing in the same direction, have been obtained in this country by experiments suggested by, or variations of, the well-known experiments of Moser.

Engraving on Wood.—The *Photographic News* contains a much more simple and efficient method than any previously devised for placing Photographs on the Wood for the use of Wood Engravers. Of course there is little more difficulty in printing a photograph on wood than on paper ; but as yet the means adopted have been found to render the face of the wood block so rotten or brittle that it was scarcely possible to produce a good engraving. Thin films of albumen, of dry collodion, of collodion transferred from the glass upon a bituminous varnish, of a coating of gelatine and alum followed by a solution of hydrochlorate of ammonia, &c., have formed the bases of the different methods proposed in this country and on the Continent ; but in all, or nearly all, it has been found necessary to subject the wood block to a fixing bath, to the certain injury of its surface. The method proposed by Mr. Crookes seems liable to no such objection. The block is to be covered by candle-light or in a darkened room, "with a mixture composed of oxalate of silver and water, to which may be added a little gum or of pulverised Bath brick, to suit the convenience of the engraver." The preparation is spread by the finger, precisely as the draftsman now spreads his solution of flake white before making his drawing on the block. It is then put in a dark place to dry, and, as soon as dry, is ready to receive the picture, which is obtained by the ordinary process of photographic printing. "The block requires no subsequent washing, nor any preparation of any description, before being placed in the hands of the engraver," who then proceeds with his engraving in the usual way. But he is warned that he "must not expose the block to the direct action of the solar rays while working at it, or it will gradually blacken on the surface ; exposure to diffused daylight, however, has no deleterious effect on it, unless it be continued for a great length of time—say several hours." Wood-blocks, after being prepared with the oxalate of silver, may be kept ready for use for months without deterioration.

Photo-lithotype.—This is the result of a Phototypic process, and is well worth attention from the applications it may be capable of.

It is well known that a lithograph is formed by preparing the surface of a particular sort of dolomitic stone with a gummy preparation, which can be wetted with water, and then drawing upon it with a soapy chalk or ink, which can be rendered incapable of being touched by water, though instantly attaching itself to the greasy material of printers' ink. A similar employment of surface affinities is adopted for the preparation of the metallic plates in the processes called Zincography, and Anastatic printing. The action of bichromate of potassium has been called in here also; and the gum surface is so modified by it under the influence of light as to admit of the substitution of a soap or grease-touching surface only on those parts where the light has not acted, or in proportion to the protection from the luminous influence which has been imparted to it by the shadow. Here, too, for large surfaces of shadow a graining is employed, but it is the production in use already for the graining of the lithographs, and consists merely in a roughened surface communicated to the stone.—*Saturday Review*, No. 174.

Platinum Toning.—Mr. Burnett has exhibited to the British Association some photographs toned with a solution of bichloride of platinum, rendered strongly adhesive by carbonate of soda, the previous addition of a little tartaric acid also being apparently a further improvement. Platinum Toning has been introduced into France some years ago; but, as far as Mr. Burnett could find out, did not seem there or here to have been found generally satisfactory, apparently from chemical reasons, which Mr. Burnett mentioned. The addition of carbonate of soda, as made by Mr. Burnett, was an attempt to remove some of those objections and render platinum more available.

New Lens.—Mr. Sutton has stated to the British Association that by placing a double concave small Lens between two large plane concave lenses, and taking care to adjust their respective distances, attending also to the centering of them, he has succeeded in producing a lens entirely free from distortion.

Michro-Photography.—Dr. Muller speaks of a Micro-Photograph shown to him which was scarcely perceptible to the naked eye, but as a faint spot on the glass; but which, on being looked at through a microscope, was seen to be a full-length portrait of the Emperor Napoleon III., in a military costume. We have seen another which represented the well-known picture of the Queen and twelve naval officers in council, every feature of each individual being perfectly distinct on the application of a microscope of rather high magnifying power, although a threepenny-piece would have covered the entire photograph, and something more. Mr. Alfred Reeves has recently forwarded to us a specimen of one of these minute pictures, which consists of a plate containing the portraits of the kings and queens of England since the time of the Conquest. Here, on a space not larger than the one-sixteenth of an inch square, may be perceived a miniature "National Portrait Gallery," with a portrait of every king and queen surrounding Her Majesty, who is properly made the centre figure of the interesting group. We have already referred on a previous occasion to some of the uses to which micro-photography might be put, but there are some others which we may briefly notice. Suppose, for example, that two portions of the same army are encamped at a distance of one or two miles apart, the communication being cut off by the enemy, or rendered almost impossible by the use of "arms of precision;" a very simple arrangement would enable the fullest written despatches to pass from one portion of this army to the other, without risk, and almost with the rapidity of electricity. The despatch is written, and a micro-photograph taken, which reduces it within the limits of—if a long one—a square inch. This is placed inside one of the hollow conical bullets and the end closed with lead. The hoisting of a given signal would announce that a messenger was about to be despatched; and, with the accuracy which distinguishes our improved rifles, a commander might have his despatches delivered with a speed and punctuality to which no post-office has yet attained. In the case of a beleaguered town, too, such a method of communication between its inhabitants and an army approaching to relieve it might be invaluable. It has not the drawback either of requiring men to have a special training for the purpose of carrying on these communications; all the manipulations necessary might be learnt in less than a week. Neither would there be any necessity for using a cipher, as there would be no risk of the despatch falling into the hands of the enemy, and hence there would be less chance of misapprehension of instructions than exists at present.—*The Photographic News.*

Photographs taken for Government Institutions.—To enable the public to derive full advantage from the Photographic negatives, made officially for the Science and Art Department, from rare and valuable objects in public and other collections, the Committee of Council on Education has caused an office for the sale of photographic impressions from such negatives to be established at the South Kensington Museum. Photographic negatives, made by order of the Trustees of the British Museum, and for the War, and other Government Offices, will also be sold.

NEW ACTINOMETER.

Dr. Woods, of Parsonstown, has invented this new instrument for the measurement of the actinic effect of light, which promises to relieve photography of half its failures, and to be of still greater advantage to its science, by rendering the use of the peroxalate of iron as a photometric agent both manageable and simple. The instrument is described and illustrated in the *Philosophical Magazine* for Jan., 1860.

Natural History.

ZOOLOGY.

PROGRESS OF ZOOLOGY AND BOTANY.

"It is," said Sir William Jardine, at the late meeting of the British Association, "in the younger countries where we see an advance more evident. Australia and Van Diemen's Land, now that wealth permits time and luxury, have attended to science; and in most of the journals of those countries we have original observers, and by and by we shall have the results of the study of the remarkable productions of these lands made where they live and grow. New Zealand, also, has its scientific journal. It is, however, in the New World where the greatest activity at present prevails. She has already, with credit to herself, sent out scientific expeditions of a general character, and those of Wilkes, and Rae, and Kane are well known, and huge works have sprung from each; but the botanists of territory now claimed by the American people, have given rise to surveys and exploratory expeditions at home, and these are proceeding in all directions to fix the boundary lines, and the best railway routes to the Pacific—naturalists and draftsmen, in fact, all the necessary staff, accompanying each expedition—the results of which are published in reports to Congress, in which they are assisted by the Smithsonian Institution of Washington. But the work of the greatest magnitude and importance to America is *Contributions to the Natural History of the United States*, by Agassiz, originally advertised to be completed in ten large volumes, but the subscription has so well filled as to allow its extension even beyond the contemplated limits. Two volumes for the first year on the testudinata or tortoises, have been published, illustrated by thirty-four plates. An important part of these volumes is an introductory essay, which has been republished separately in an 8vo volume. Louis Agassiz's *Essay on Classification* embraces the whole range of the subject, which he treats in a wider and more comprehensible and less mechanical manner than has hitherto been done; but while I thus praise the work and the manner in which it is treated, and agree with a great many of the positions he has taken up, I must warn its readers that some subjects are treated in a way Prof. Agassiz will not be able to maintain; and that to those who are unable or unwilling to think for themselves, the author's reputation will prove a guarantee not altogether to be trusted. It must be studied with great care and great caution. Nevertheless, I look upon it as the remarkable book of the year. There is another work upon a similar subject, from which we may expect some curious reasonings, *On the Origin of Species and Varieties*, by Charles Darwin."

THE GENETIC CYCLE IN ORGANIC NATURE. BY D. G. OGILVIE.

derivation, Dr. Ogilvie observes, is now generally allowed as the sole origin of organic beings; and the subject of discussion among physiologists is no longer the admissibility of spontaneous generation, but the nature of the derivation, as the case may be, from a single parent or a pair. The former mode of origin by what has been termed "gemmation," or the "budding process," plays a very conspicuous part in the propagation of many of the lower species; and by its periodic recurrence in conjunction with the other form of reproduction, gives rise to the singular phenomena known as alternation of generations. All cases of alternation are not, however, to be regarded as precisely parallel: and it is the object of the present paper to point out certain differences dependent on the period of the life-history of a species in which the process of gemmation is interpolated.

Three stages are distinguished in the life-history—the protomorphic, or that prior to the first appearance of the organization most characteristic of the species—the orthomorphic, or that marked by such typical organism—and the gamomorphic, or that of the development of the reproductive organs. In each of these stages we may have a process of gemmation interpolated. The results contrast, especially as it occurs in the first and last. As examples of the former, the trematode and cystic entozoa were referred to in the animal kingdom, and the mosses among plants, in all of which certain provisional forms are interposed between the ovum and the embryonic rudiment of the typical form. The polypifera and cestoidea among animals, on the other hand, and the ferns among vegetables, furnish illustrations of alternation dependent on gemmation in the gamomorphic stage, and arising from the reproductive organs acquiring the characters of detached and often highly organized structures comparable to independent animals or plants. The hood-eyed medusæ become in this way much more conspicuous organisms than the polype stock, whose organs they really are. The cestoidea are remarkable as presenting instances of a double alternation, from a process of gemmation occurring both in the cystic or protomorphic, and in the tænioid or gamomorphic stages.

The author concludes by indicating a parallelism between the phenomena of alternation and certain points in the embryogeny of the higher animals, and in the maturation of the reproductive organs. The formation of double monsters in the higher animals, the normal twin embryo of the polyzoa, the variable number of tænia heads budded off by the cystic entozoa, and the phenomena of development among the echinodermata, are referred to as indicating a gradual transition from the implantation of the embryo on the germ-mass of the ordinary ovum, to cases of well-marked alternation—while the reproductive process in the polyzoa and hydraform polypes, in the salpæ and in some annelides, and the phenomena of impregnation in the coniferæ among vegetables, are brought forward in illustration of a similar transition from the development of the normal reproductive organs, to the formation of conspicuous sexual zooids;—and in proof of distinctions founded on the complexity of the structures themselves not being of essential importance, reference was made to the males of the rotifera and cirrhipeda, which, though animals with an individuality entirely distinct even from the ovum, are much more defective in organization than some of the sexual zooids now referred to, as the hood-eyed medusæ.—*Proceedings of the British Association.*

PROFESSOR OWEN ON THE GORILLA.

Before referring to earlier indications of this truly extraordinary animal, the Professor briefly recapitulated the steps which had led to the authentic knowledge of this great anthropoid ape since the first communication received from its discoverer, the missionary, Dr. Savage, in 1847. Various evidences of the Gorilla,—skulls, skeletons, and finally entire animals—had successively reached the museums of Paris and London, and, with those sent to Boston, U.S., had been described by the professors of zoology and comparative anatomy in those cities. The description of the entire skeleton of the gorilla had been communicated by the author to the Zoological Society in 1851, and by Professor Duvernoy to the Academy of Sciences of Paris in 1853; that of the stuffed specimen in the Jardin des Plantes, by Professor Isidore Geoffroy St. Hilaire, appeared in the tenth volume of the *Archives du Muséum* in 1858. The differences in the results of the observations by the American, French, and English naturalists relate, chiefly, to the interpretation of the facts observed. Dr. Wyman agrees with Professor Owen in referring the gorilla to the same genus as the chimpanzee, but differs from him in regarding the chimpanzee as being more nearly allied to the human kind. Professor Duvernoy and Geoffroy St. Hilaire consider the differences in the osteology, dentition and outward characters of the gorilla to be of generic importance and enter it in the zoological catalogue as *Gorilla gina*, the specific name being that by which the beast is known and dreaded by the natives of Gaboon. The French naturalists also concur with the American in placing the gorilla below the chimpanzee in the zoological scale, and some have lately been disposed to place both below the hylobates or long-armed apes.

Deferring the discussion of these questions, the author proceeded to describe the external characters of the adult male gorilla as they were exhibited by the specimen preserved in spirits. He first called attention to the shortness, almost absence, of neck, due to the backward position of the junction of the head to the trunk, to the great length of the cervical spines, causing the "nape" to project beyond the "occiput," to the great size and elevation of the scapulæ, and to the oblique rising of the clavicles from their sternal attachments to above the level of the angles of the jaw. The brain-case, low and narrow, and the lofty ridges of the skull, make the cranial profile pass in almost a straight line from the occiput to the superorbital ridge, the prominence of which gives the most forbidding feature to the physiognomy of the gorilla; the thick integument overlapping that ridge forming a scowling pent-house over the eyes. The nose is more prominent than in the chimpanzee or orang-utan, not only at its lower expanded part, but at its upper half, where a slight prominence corresponds with that which the author had previously pointed out in the nasal bones. The mouth is very wide, the lips large, of uniform thickness, the upper one with a straight, as if incised margin, not showing the coloured lining membrane when the mouth is shut. The chin very short and receding, the muzzle very prominent. The eyelids with eye-lashes, the eyes wider apart than in the orang or replaces them by principles which we ought to consider injurious to the human organism, since they are not found in the blood or other animal fluids."—*Répertoire de Chimie.*

LEAD IN SNUFF.

It has long been known that Snuff contains Lead when it has been kept in vessels made of that metal. A commission of German chemists have determined, after long research, that snuff wrapped in lead, even when covered with paper, or combined with tin, gradually becomes poisonous by acting upon and taking up the metal. They recommend snuff to be kept in paper, coated with wax, gutta percha, or some resinous substance.—*Journal de Pharmacie.*

COAGULATION OF THE BLOOD.

Dr. Davy, F.R.S., has communicated to the Royal Society of Edinburgh the following paper:—

Dr. Richardson, in a recent and elaborate work on the Blood, an extension of a Prize Essay on the cause of the Coagulation of this fluid, has endeavoured to prove that this phenomenon is of a chemical kind, depending on the escape of the volatile alkali.

Dr. Davy describes three sets of experiments, which he has instituted for the purpose of testing Dr. Richardson's hypothesis. In all his trials on blood, he has used that of the common fowl, its properties being best adapted to the objects in view. The results obtained were briefly the following:—

1. Ammonia added to the blood in small quantities did not prevent its coagulation; in larger quantities it retarded coagulation, and rendered the blood viscid.
2. On exposing mixtures of blood and ammonia, and of water and ammonia, to the open air, the loss of weight sustained in two or three minutes—the time required for the coagulation of the blood—was hardly appreciable, using a very delicate balance.
3. The moist fibrin of the blood subjected to the action of ammonia was found to be rendered transparent and viscid, but to be very slightly soluble.

These results, and others, such as the coagulation of the blood in close vessels, and the volatile alkali not having hitherto been detected in healthy blood, have led the author to the conclusion that the phenomenon under consideration still remains an unsolved problem; and that on the ground of mere probabilities it is not easy to say which of the two chief hypotheses advanced concerning it—the chemical and the vital—is deserving of preference.

RED DYES.

Mr. Brooman has patented an improvement in the preparation of Red Dyes. The inventor boils for fifteen or twenty minutes a mixture of aniline and anhydrous bichloride of tin. At first the mixture assumes a yellow, then a reddish tint, and finally changes to a beautiful red. The mixture is liquid while hot, but when cold becomes gelatinous. The gelatinous mass is boiled with water, and filtered hot; and the colouring matter is precipitated from the filtered liquor as it cools. To completely separate this colouring matter, the patentee dissolves in the liquor either a tartrate, acetate, an alkaline or earthy chloride, an alkaline phosphate or pyrophosphate, or chloride of mercury, which precipitates the whole of the colouring matter. For dyeing, either the solution obtained by boiling the mixture in water, or the solid colour dissolved in water is used. The usual mordants, except the mineral acids, may be used with it. To obtain a solution sufficiently strong to print with, the mixture of aniline and bichloride of tin is treated while hot with acetic acid, alcohol, or wood spirit, and the colouring matter is precipitated as before described. Another red dye is produced by mixing with aniline bichloride of mercury, perchloride of iron, or protochloride of copper, and treating this mixture as the former. The inventor gives the name of Fuchsiacine to these colours, from their resemblance to that of the fuchsia.

MADDER.

THE colouring properties of this invaluable dyestuff, prepared from the root of the Rubia Tinctorum, is the subject of a long and interesting paper by Dr. Edward Schunk, F.R.S., in a late number of the *Journal of the Chemical Society*. Madder attained its eminent position in dyeing without the aid of scientific chemists, and it is only lately that their attention has been directed to it. Since they have done so, however, various interesting discoveries have been made—viz., Alizarine and Purpurine, and, in consequence, Garancine, by Robiquet, Colin, Persoz, and others; and Xanthine by Kuhlmann. To these Dr. Schunk has added Rubian, Verantine, and compounds from them. He gives, in conclusion, the results of his researches in a tabular form at the end of the paper. To it is subjoined an account of the optical characters of Purpurine and Alizarine, with an illustration, by Professor G. G. Stokes.

NEW GREEN COLOUR.

DR. CRACE CALVERT has presented to the Manchester Literary and Philosophical Society, in the name of Mr. Arnaudon (from Turin), a paper, and samples of Green Colours used in painting and printing, and especially referred to two new chrome greens, one of which is a new compound, corresponding to the monohydrate of sesquioxide of chrome $Cr^2 O^3 HO$. The author commences in his work to point out the qualities which a good green ought to possess, in order to be suitable for painting. Then he reviews in a few words the different greens which are found at present in the market, together with the nature and properties of the same. Beginning with the history of the works already published on this subject, he next gives the description of his process for preparing his monohydrate of sesquioxide of chrome, and which consists in exposing the bichromate of potash mixed with phosphoric acid and any desoxydizing agent (for example, ammonia), for some time to the action of heat. The soluble salts are then removed by washing.

The green so prepared has not only a beautiful shade, but, like that of Mr. Guignet (made by decomposing the borate of oxide of chrome by water), possesses the curious property of remaining green under the influence of artificial light. Dr. Calvert also presented some muslins printed by M. Camille Kæchlin, of Mulhouse, with fuchsine, a product obtained from the aniline of coal tar.

This colour was very remarkable from the exquisite bloom of the pink shade obtained when fixed with albumen.

MAUVE DYE.

THE *Art Journal* states that the exquisitely beautiful Dye for silks, the *Mauve*, is prepared by taking equivalent proportions of sulphate of aniline and bichromate of potash, dissolving them in water, mixing, and allowing them to stand for several hours. The whole is then thrown upon a filter, and the black precipitate which has formed is washed and dried. This black substance is then digested in coal-tar naphtha, to extract a brown, resinous substance; and finally digested with alcohol, to dissolve out the colouring matter, which is left behind, on distilling off the spirit, as a coppery friable mass. This is the dyeing agent producing all the charming varieties of purples known by the name *mauve*, which, as it appears to us somewhat inappropriately, has been given to this colour. The particularity of these purples consists in the peculiar blending of the red and blue of which they are constituted. These hues admit of almost infinite variation; consequently, we may have many varieties of *red mauve*, and as many of *blue mauve*, and any depth of tint can be secured. The permanence of these hitherto fugitive combinations is their strongest recommendation.

NEW BLACK DYE.

A PARIS Correspondent of the *Critic* says that the New Black Dye which has just been discovered in Algeria is the great object of interest amongst chemists and manufacturers just at this moment. The discovery has been made by M. Muratere, and is a vegetable substance gathered from a tree which grows in immense profusion all over the colony. It is destined, according to the report made upon its merits, to replace every other substance in use for the same purpose up to this day, and is more brilliant than any dye hitherto known. The discoverer has registered his patent for its use under the name of "Algerian Campeachy wood." It would appear that M. Muratere intended to have reserved the publicity of his new dye till the Exposition of 1860; but upon the publication of the Minister's circular letter announcing that no exposition will take place, as had been anticipated, he has determined on making the advantages of his discovery known at once. As no reason is given in the Minister's letter for not holding the exhibition, and no term fixed for the reparation of its omission in 1859, of course gossiping tongues are not idle in ascribing all kinds of ill-natured suppositions to the measure. A company of weavers, dyers, embroiderers, and designers is reported to have arrived at Bordeaux from Cashmere, for the purpose of forming an establishment in the neighbourhood of Paris for the manufacture of "real" Cashmere shawls. The idea is said to have originated with the Emperor himself, who, disgusted with the length of time which has been occupied in making the famous green shawl for the Empress, ordered by his Majesty more than five years ago, suggested to an enterprising shawl merchant of Marseilles the facility of procuring native workmen, who, under the vigilant eyes of Europeans, would be taught to work with activity.

GILDING TEXTILE FABRICS.

M. **BUROT** has discovered a method of Gilding Stuffs by means of electrical agency. The piece to be gilt is dipped into a solution of nitrate of silver and ammonia; after remaining in this for two hours, it is taken out, and, when dry, exposed to a current of pure hydrogen gas, which reduces the salt, and leaves the silver in a metallic state on the stuff. A silvered surface is thus obtained, which is easily gilt over by the usual galvanoplastic methods.—*Critic.*

SOLIDIFICATION OF OILS.

M. **PERRA**, in a paper addressed to the French Academy of Sciences, has described a method for transforming Vegetable Oils into Solid Masses, through the action of chloride of sulphur. This substance, when composed so as to contain the largest proportion possible of sulphur, is poured in the oil at the common temperature; the mixture is well stirred and allowed to stand. By degrees it becomes warm, and the solidification takes place. The operation must be performed on small quantities at a time, in order to avoid the generation of too high a temperature, which would drive off the chloride by evaporation, and perhaps even carbonise the oil. As soon as the combination is effected, the mass is poured out on a plate of glass, carefully flattened, and then left to cool; at the end of five or six minutes it becomes hard. A second stratum may then be cast on the former, and so on until the requisite thickness has been obtained. Care must be taken, however, to prevent the interposition of moisture between the layers, otherwise they will not join. One hundred parts of linseed oil and twenty-five parts of chloride of sulphur will produce the greatest hardness possible; if the proportion of chloride be reduced to twenty or fifteen parts, the mass will be supple, like india-rubber; and 100 parts of oil with only five of chloride will thicken the oil considerably without hardening it. In this state it is soluble in all the usual mediums, such as oil of turpentine for example, which dissolve common oils. If a certain quantity of linseed oil be diluted with thirty or forty times its weight of sulphuret of carbon, and with one-fourth of its weight of chloride of sulphur, a liquid will be obtained which will not dry for some days. If this combination be laid with a brush on glass, wood, &c., the sulphuret of carbon will immediately evaporate, and the residue will become a varnish. We may state that some of these facts are not entirely new: in 1849, Professor Niclès, of the faculty of Nancy, announced the solidification of oil by the chloride of sulphur; and in the same year M. Rochelder observed it, and published an account of it in *Dingler's Polytechnic Journal.—Critic.*

REMARKABLE SOLVENT.

IT is now discovered, it appears, that if a piece of copper be dissolved in ammonia a solvent will be obtained, not only for lignine, the most important principle of all woody fibre, such as cotton, flax, paper, &c., but also for substances derived from the animal kingdom, such as wool and silk. By the solution of any one of these, an excellent cement and waterproofer is said to be formed; and, what is equally important, if cotton fabrics be saturated with the solution of wool, they will be enabled to take the dyes—such as the lac dye and cochineal—hitherto suited to woollen goods only. Hydriodide of ammonia, we may also observe, was not long since discovered to be an equally remarkable solvent of the most refractory, or at least insoluble, mineral substances. Now it is an interesting circumstance that ammonia, according to Van Helmont, and other old chymists and alchymists, was one of the requisite materials in the formation of the "alkahest," or "universal solvent," of the ancient sages! In the cupride of ammonium (if we may so call the solvent here first spoken of), we seem to have the solvent of silk which we lately desiderated in our remarks on the insulation of submarine telegraphic wires.—*Builder.*

MANUFACTURE OF KELP.

A PAPER has been read to the British Association "On Proposed Improvements in the Manufacture of Kelp," by Dr. Wallace. The chief defects of the present system were pointed out, and, by way of remedy, it was proposed that sheds should be erected for the desiccation of the weeds and their preservation from rain, and that the weeds should be burned or charred at a low temperature into a loose ash, instead of being strongly ignited and subjected to fusion as now practised. By this process the loss of iodine that appears at present to occur, and the production of sulphur compound, which cause an enormous consumption of vitriol in their decomposition, would be entirely avoided. Dr. Wallace described the varieties of weeds used by the kelpers, and the results of a series of experiments, conducted with the object of estimating the quantities of iodine and potash in the ashes of the various weeds when prepared by the improved process. From these it appeared that the ashes of the deep-sea tangle contained 28 lb., that of the black wreck, 9 lb., and that of the yellow or bladder wreck, 6 lb. of iodine per ton of 22½ cwt. Dr. Wallace concluded by calling upon the proprietors of the kelp-bearing shores to interest themselves more than they have hitherto done in this important manufacture, and to expend some capital in the erection of sheds, and purchase of such simple apparatus as the islanders are capable of using with advantage. By doing so, they would confer an important benefit upon their poor tenants, and insure greatly augmented returns from their estates.

CARBON INK.

MR. JOHN SPILLER, F.C.S., of the War Department, has communicated to the *Chemical News*,* No. 1, a paper on the employment of Carbon as a means of Permanent Record. The imperishable nature of carbon, in its various forms of lamp black, ivory black, wood charcoal, and graphite or black lead, holds out much greater promise of being usefully employed in the manufacture of a permanent writing material; since, for this substance, in its elementary condition, and at ordinary temperatures, there exists no solvent nor chemical reagent capable of effecting its alteration.

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* *The Chemical News, with which is incorporated the Chemical Gazette,* under the able editorship of Mr. William Crookes. This journal comprises the sections of Scientific and Analytical Chemistry, Technical Chemistry, Pharmacy, and Toxicology, Chemical Notes, and Laboratory Memoranda; it is ably edited.

The suggestion relative to the mode of applying carbon to these purposes, which it is intended more particularly now to enunciate, depends on the fact of the separation of carbon from organic compounds, rich in that element, sugar, gum, &c., by the combined operation of heat and of chemical reagents, such as sulphuric and phosphoric acids, which exert a decomposing action in the same direction; and by such means to effect the deposition of the carbon within the pores of the paper by a process of development to be performed after the fluid writing ink has been to a certain extent absorbed into its substance. A system of formation by which a considerable amount of resistance, both to chemical and external influences, appears to be secured. An ink of the following composition has been made the subject of experiment:—

Concentrated sulphuric acid, deeply coloured with indigo	1 fluid ounce.
Water	6 ,, ,,
Loaf sugar	1 ounce troy.
Strong mucilage of gum arabic	2 to 3 fluid ounces.

Writing traced with a quill or gold pen dipped in this ink dries to a pale blue colour, but if now a heated iron be passed over its surface, or the page of manuscript held near a fire, the writing will quickly assume a jet black appearance, resulting from the carbonisation of the sugar by the warm acid, and will have become so firmly engrafted into the substance of the paper as to oppose considerable difficulty to its removal or erasure by the knife. On account of the depth to which the written characters usually penetrate, the sheets of paper selected for use should be of the thickest make, and good white cartridge paper, or that known as "cream laid," preferred to such as are coloured blue with ultramarine, for in the latter case a bleached halo is frequently perceptible around the outline of the letters, indicating the partial destruction of the colouring matter by the lateral action of the acid.

The writing produced in this manner seems indelible; it resists the action of "salts of lemon," and of oxalic, tartaric, and diluted hydrochloric acids—agents which render nearly illegible the traces of ordinary black writing ink; neither do alkaline solutions exert any appreciable action on the carbon ink. This material possesses, therefore, many advantageous qualities which would recommend its adoption in cases where the question of permanence is of paramount importance; but it must, on the other hand, be allowed that such an ink, in its present form, would but inefficiently fulfil many of the requirements necessary to bring it into common use. The peculiar method of development rendering the application of heat imperative, and that of a temperature somewhat above the boiling point of water, together with the circumstance that it will be found impossible with a thin sheet of paper to write on both sides, must certainly be counted among its more prominent disadvantages.

Though not perhaps capable of employment on the animal tissues, vellum and parchment, there is every probability of its successful application in connexion with the new material produced by the action of strong acids on paper, and known under the name of vegetable parchment.

LUBRICATING CARTRIDGES.

DR. SCOFFERN has patented a composition for lubricating cartridges. He uses a mixture of equal weights of paraffine and naphthaline, preferring, however, a compound made by melting india-rubber in an open vessel over a fire, and thoroughly mixing with it four times its weight of paraffine, and one-half its weight of naphthaline. The mixture when wanted for use is melted in an oil bath, and the temperature is kept as near 240° as possible. The advantage of the compound is said to lie in the fact that it is volatilised without change on the application of heat.

BLAZE-PROOF DRESSES.

THE frequent melancholy accidents of ladies' dresses taking fire teach a lesson which must not be neglected. The light fabrics manufactured for ladies' dresses should be made blaze-proof. Nothing can be more simple. The most delicate white cambric handkerchief, or fleecy gauze, or the finest lace, may, by simply soaking in a weak solution of chloride of zinc, be so protected from blaze that if held in the flame of a candle they may be reduced to tinder without blazing. Dresses so prepared might be burnt by accident without the other garments worn by the lady being injured. The dresses of stage dancers are prepared in the way we recommend. Why are dancing ladies of rank to be exposed to danger from which their dancing sisters by profession are protected?

A valuable discovery has been made by Messrs. Versmann and Oppenheim, of 7, Bury-court, St. Mary-axe, and was the subject of a paper lately read before the British Association. It is that sulphate of ammonia and tungstate of soda have the property of making linen and cotton fabrics uninflammable, and do not injure or discolour them in washing.

In the conversation which ensued, Mr. Grahame stated that the investigation of this subject had been at first set about at the wish of Her Majesty, who longed to see some mode discovered by which light dresses might be less liable than at present to endanger the lives of their owners through catching fire. Preparations of these salts are used in the Royal laundry; and their general adoption would prevent a vast number of those dreadful accidents which now almost daily occur to children and others. To this we have to add that MM. Doebereiner and Alsmer, after discussing the merits of borax, alum, and soluble glass, for diminishing the combustibility of cotton tissues, recommend phosphate of ammonia, which is cheap, and can be easily combined with sal ammoniac, and introduced into the starch with which the tissues are prepared.—*Répertoire de Chimie.*

PHOTOGRAPHIC PROGRESS.

THE following are a few of the striking results of the past year:—

Carbon Printing.—At the meeting of the Photographic Society, January 4, 1859, Mr. Pouncey, of Dorchester, read a paper on his process of Carbon Printing, which has excited so much interest and curiosity. The paper is published at length, with Mr. Pouncey's subsequent explanations, in the *Photographic Journal* of January 8. Referring to that for all details, we may state generally that Mr. Pouncey's method consists in preparing the paper for printing on, by spreading over it by means of a hog's-hair brush a mixture of finely powdered vegetable carbon, and equal parts of a saturated solution of bichromate of potash, and a common solution of gum arabic; the proportions being one drachm of the carbon to four drachms of each of the solutions. After it is dry the paper is ready for printing on by exposure in a printing-frame in the usual manner—the time of exposure being from four to five minutes in the sun, and from ten to fifteen in the shade, but varying according to season, character of negative, &c. In washing the picture, it must lie under water for at least five or six hours, when the pictures, of which previously scarcely a trace was perceptible, will become visible. The principal difference in the appearance between a carbon print and one prepared with silver being, according to Mr. Pouncey, "that one may probably fade, while the other remains imperishable."

Discovery of a new action of light, and that light could be stored up, as it were, for use whenever required.—M. Nièpce having invited Mr. Wheatstone to visit his laboratory in the Louvre, and "see with his own eyes a photograph made by light which had been stored up for several months," the *Photographic News* of Feb. 18 contains a communication from the Abbé Moigno, giving full particulars of the result:—

> "M. Nièpce took a tube containing a piece of pasteboard which had been impregnated with tartaric acid, insolated for a length of time, and rolled up in it, in the month of June last, and the tube then hermetically closed. He and Professor Wheatstone placed themselves in a dark room; M. Nièpce had a sheet of sensitized paper, on which he placed a piece of paper printed upon in large letters; he then opened the tube, holding it vertically, with the orifice downwards, and this orifice he placed on the printed paper which covered the sensitive paper; the tube was left in this position for about ten minutes, at the end of which time he removed it. The circle on the paper blackening in all its parts where it was not protected by the printed letters, at once visibly manifested the action of the light; the printed paper being removed, the characters were found to be very neatly traced in white, or forming a negative proof; this negative was treated like ordinary negatives, that is to say, it was fixed, and Professor Wheatstone placed it in his portfolio, to produce it before the Royal and Photographic Societies; a proof obtained by means of light that had been imprisoned for six months. The experiment, therefore, succeeded perfectly. Professor Wheatstone takes with him two tubes, one of which was placed in our hands on the 7th February, 1858, more than a year ago, the other closed in the month of June last, like that which was so efficacious under his inspection, and he will himself repeat the experiment in London before his illustrious colleagues, who will not then retain even the shadow of a doubt as to the reality of the persistent activity of the light."

M. Moigno gives in the paper referred to a formula by which "every one who wishes may succeed" in obtaining similar results.

The editor of the *Photographic News* has seen the picture taken in the presence of Professor Wheatstone, and states that—

> "The distinctness with which the printed paper used as a negative is reproduced on the sensitized paper, is perfectly surprising."

The same paper also contains an account of another remarkable discovery recently made by M. Nièpce :—

> "Having prepared a paper with nitrate of silver and chloride of gold, he placed a negative upon it and enclosed the whole in a substitute for the ordinary printing frame, and submitted it to the action of *radiant heat;* the result answered his expectations. We have before us pictures obtained by him by these means, which are very distinct, even to the extent of reproducing legibly the inscription around a shield."

This result is probably due to molecular action ; and indeed some very curious results, pointing in the same direction, have been obtained in this country by experiments suggested by, or variations of, the well-known experiments of Moser.

Engraving on Wood.—The *Photographic News* contains a much more simple and efficient method than any previously devised for placing Photographs on the Wood for the use of Wood Engravers. Of course there is little more difficulty in printing a photograph on wood than on paper ; but as yet the means adopted have been found to render the face of the wood block so rotten or brittle that it was scarcely possible to produce a good engraving. Thin films of albumen, of dry collodion, of collodion transferred from the glass upon a bituminous varnish, of a coating of gelatine and alum followed by a solution of hydrochlorate of ammonia, &c., have formed the bases of the different methods proposed in this country and on the Continent; but in all, or nearly all, it has been found necessary to subject the wood block to a fixing bath, to the certain injury of its surface. The method proposed by Mr. Crookes seems liable to no such objection. The block is to be covered by candle-light or in a darkened room, "with a mixture composed of oxalate of silver and water, to which may be added a little gum or of pulverised Bath brick, to suit the convenience of the engraver." The preparation is spread by the finger, precisely as the draftsman now spreads his solution of flake white before making his drawing on the block. It is then put in a dark place to dry, and, as soon as dry, is ready to receive the picture, which is obtained by the ordinary process of photographic printing. "The block requires no subsequent washing, nor any preparation of any description, before being placed in the hands of the engraver," who then proceeds with his engraving in the usual way. But he is warned that he "must not expose the block to the direct action of the solar rays while working at it, or it will gradually blacken on the surface ; exposure to diffused daylight, however, has no deleterious effect on it, unless it be continued for a great length of time—say several hours." Wood-blocks, after being prepared with the oxalate of silver, may be kept ready for use for months without deterioration.

Photo-lithotype.—This is the result of a Phototypic process, and is well worth attention from the applications it may be capable of.

It is well known that a lithograph is formed by preparing the surface of a particular sort of dolomitic stone with a gummy preparation, which can be wetted with water, and then drawing upon it with a soapy chalk or ink, which can be rendered incapable of being touched by water, though instantly attaching itself to the greasy material of printers' ink. A similar employment of surface affinities is adopted for the preparation of the metallic plates in the processes called Zincography, and Anastatic printing. The action of bichromate of potassium has been called in here also; and the gum surface is so modified by it under the influence of light as to admit of the substitution of a soap or grease-touching surface only on those parts where the light has not acted, or in proportion to the protection from the luminous influence which has been imparted to it by the shadow. Here, too, for large surfaces of shadow a graining is employed, but it is the production in use already for the graining of the lithographs, and consists merely in a roughened surface communicated to the stone.—*Saturday Review*, No. 174.

Platinum Toning.—Mr. Burnett has exhibited to the British Association some photographs toned with a solution of bichloride of platinum, rendered strongly adhesive by carbonate of soda, the previous addition of a little tartaric acid also being apparently a further improvement. Platinum Toning has been introduced into France some years ago; but, as far as Mr. Burnett could find out, did not seem there or here to have been found generally satisfactory, apparently from chemical reasons, which Mr. Burnett mentioned. The addition of carbonate of soda, as made by Mr. Burnett, was an attempt to remove some of those objections and render platinum more available.

New Lens.—Mr. Sutton has stated to the British Association that by placing a double concave small Lens between two large plane concave lenses, and taking care to adjust their respective distances, attending also to the centering of them, he has succeeded in producing a lens entirely free from distortion.

Michro-Photography.—Dr. Muller speaks of a Micro-Photograph shown to him which was scarcely perceptible to the naked eye, but as a faint spot on the glass; but which, on being looked at through a microscope, was seen to be a full-length portrait of the Emperor Napoleon III., in a military costume. We have seen another which represented the well-known picture of the Queen and twelve naval officers in council, every feature of each individual being perfectly distinct on the application of a microscope of rather high magnifying power, although a threepenny-piece would have covered the entire photograph, and something more. Mr. Alfred Reeves has recently forwarded to us a specimen of one of these minute pictures, which consists of a plate containing the portraits of the kings and queens of England since the time of the Conquest. Here, on a space not larger than the one-sixteenth of an inch square, may be perceived a miniature "National Portrait Gallery," with a portrait of every king and queen surrounding Her Majesty, who is properly made the centre figure of the interesting group. We have already referred on a previous occasion to some of the uses to which micro-photography might be put, but there are some others which we may briefly notice. Suppose, for example, that two portions of the same army are encamped at a distance of one or two miles apart, the communication being cut off by the enemy, or rendered almost impossible by the use of "arms of precision;" a very simple arrangement would enable the fullest written despatches to pass from one portion of this army to the other, without risk, and almost with the rapidity of electricity. The despatch is written, and a micro-photograph taken, which reduces it within the limits of—if a long one—a square inch. This is placed inside one of the hollow conical bullets and the end closed with lead. The hoisting of a given signal would announce that a messenger was about to be despatched; and, with the accuracy which distinguishes our improved rifles, a commander might have his despatches delivered with a speed and punctuality to which no post-office has yet attained. In the case of a beleaguered town, too, such a method of communication between its inhabitants and an army approaching to relieve it might be invaluable. It has not the drawback either of requiring men to have a special training for the purpose of carrying on these communications; all the manipulations necessary might be learnt in less than a week. Neither would there be any necessity for using a cipher, as there would be no risk of the despatch falling into the hands of the enemy, and hence there would be less chance of misapprehension of instructions than exists at present.—*The Photographic News.*

Photographs taken for Government Institutions.—To enable the public to derive full advantage from the Photographic negatives, made officially for the Science and Art Department, from rare and valuable objects in public and other collections, the Committee of Council on Education has caused an office for the sale of photographic impressions from such negatives to be established at the South Kensington Museum. Photographic negatives, made by order of the Trustees of the British Museum, and for the War, and other Government Offices, will also be sold.

NEW ACTINOMETER.

DR. WOODS, of Parsonstown, has invented this new instrument for the measurement of the actinic effect of light, which promises to relieve photography of half its failures, and to be of still greater advantage to its science, by rendering the use of the peroxalate of iron as a photometric agent both manageable and simple. The instrument is described and illustrated in the *Philosophical Magazine* for Jan., 1860.

Natural History.

ZOOLOGY.

PROGRESS OF ZOOLOGY AND BOTANY.

"It is," said Sir William Jardine, at the late meeting of the British Association, "in the younger countries where we see an advance more evident. Australia and Van Diemen's Land, now that wealth permits time and luxury, have attended to science; and in most of the journals of those countries we have original observers, and by and by we shall have the results of the study of the remarkable productions of these lands made where they live and grow. New Zealand, also, has its scientific journal. It is, however, in the New World where the greatest activity at present prevails. She has already, with credit to herself, sent out scientific expeditions of a general character, and those of Wilkes, and Rae, and Kane are well known, and huge works have sprung from each; but the botanists of territory now claimed by the American people, have given rise to surveys and exploratory expeditions at home, and these are proceeding in all directions to fix the boundary lines, and the best railway routes to the Pacific—naturalists and draftsmen, in fact, all the necessary staff, accompanying each expedition—the results of which are published in reports to Congress, in which they are assisted by the Smithsonian Institution of Washington. But the work of the greatest magnitude and importance to America is *Contributions to the Natural History of the United States*, by Agassiz, originally advertised to be completed in ten large volumes, but the subscription has so well filled as to allow its extension even beyond the contemplated limits. Two volumes for the first year on the testudinata or tortoises, have been published, illustrated by thirty-four plates. An important part of these volumes is an introductory essay, which has been republished separately in an 8vo volume. Louis Agassiz's *Essay on Classification* embraces the whole range of the subject, which he treats in a wider and more comprehensible and less mechanical manner than has hitherto been done; but while I thus praise the work and the manner in which it is treated, and agree with a great many of the positions he has taken up, I must warn its readers that some subjects are treated in a way Prof. Agassiz will not be able to maintain; and that to those who are unable or unwilling to think for themselves, the author's reputation will prove a guarantee not altogether to be trusted. It must be studied with great care and great caution. Nevertheless, I look upon it as the remarkable book of the year. There is another work upon a similar subject, from which we may expect some curious reasonings, *On the Origin of Species and Variation*, by Charles Darwin."

GENETIC CYCLE IN ORGANIC NATURE. BY D. G. OGILVIE.

derivation, Dr. Ogilvie observes, is now generally allowed as the sole origin of organic beings; and the subject of discussion among physiologists is no longer the admissibility of spontaneous generation, but the nature of the derivation, as the case may be, from a single parent or a pair. The former mode of origin by what has been termed "gemmation," or the "budding process," plays a very conspicuous part in the propagation of many of the lower species; and by its periodic recurrence in conjunction with the other form of reproduction, gives rise to the singular phenomena known as alternation of generations. All cases of alternation are not, however, to be regarded as precisely parallel: and it is the object of the present paper to point out certain differences dependent on the period of the life-history of a species in which the process of gemmation is interpolated.

Three stages are distinguished in the life-history—the protomorphic, or that prior to the first appearance of the organization most characteristic of the species—the orthomorphic, or that marked by such typical organism—and the gamomorphic, or that of the development of the reproductive organs. In each of these stages we may have a process of gemmation interpolated. The results contrast, especially as it occurs in the first and last. As examples of the former, the trematode and cystic entozoa were referred to in the animal kingdom, and the mosses among plants, in all of which certain provisional forms are interposed between the ovum and the embryonic rudiment of the typical form. The polypifera and cestoidea among animals, on the other hand, and the ferns among vegetables, furnish illustrations of alternation dependent on gemmation in the gamomorphic stage, and arising from the reproductive organs acquiring the characters of detached and often highly organized structures comparable to independent animals or plants. The hood-eyed medusæ become in this way much more conspicuous organisms than the polype stock, whose organs they really are. The cestoidea are remarkable as presenting instances of a double alternation, from a process of gemmation occurring both in the cystic or protomorphic, and in the tænioid or gamomorphic stages.

The author concludes by indicating a parallelism between the phenomena of alternation and certain points in the embryogeny of the higher animals, and in the maturation of the reproductive organs. The formation of double monsters in the higher animals, the normal twin embryo of the polyzoa, the variable number of tænia heads budded off by the cystic entozoa, and the phenomena of development among the echinodermata, are referred to as indicating a gradual transition from the implantation of the embryo on the germ-mass of the ordinary ovum, to cases of well-marked alternation—while the reproductive process in the polyzoa and hydraform polypes, in the salpæ and in some annelides, and the phenomena of impregnation in the coniferæ among vegetables, are brought forward in illustration of a similar transition from the development of the normal reproductive organs, to the formation of conspicuous sexual zooids; —and in proof of distinctions founded on the complexity of the structures themselves not being of essential importance, reference was made to the males of the rotifera and cirrhipeda, which, though animals with an individuality entirely distinct even from the ovum, are much more defective in organization than some of the sexual zooids now referred to, as the hood-eyed medusæ.—*Proceedings of the British Association.*

PROFESSOR OWEN ON THE GORILLA.

BEFORE referring to earlier indications of this truly extraordinary animal, the Professor briefly recapitulated the steps which had led to the authentic knowledge of this great anthropoid ape since the first communication received from its discoverer, the missionary, Dr. Savage, in 1847. Various evidences of the Gorilla,—skulls, skeletons, and finally entire animals—had successively reached the museums of Paris and London, and, with those sent to Boston, U.S., had been described by the professors of zoology and comparative anatomy in those cities. The description of the entire skeleton of the gorilla had been communicated by the author to the Zoological Society in 1851, and by Professor Duvernoy to the Academy of Sciences of Paris in 1853; that of the stuffed specimen in the Jardin des Plantes, by Professor Isidore Geoffroy St. Hilaire, appeared in the tenth volume of the *Archives du Muséum* in 1858. The differences in the results of the observations by the American, French, and English naturalists relate, chiefly, to the interpretation of the facts observed. Dr. Wyman agrees with Professor Owen in referring the gorilla to the same genus as the chimpanzee, but differs from him in regarding the chimpanzee as being more nearly allied to the human kind. Professor Duvernoy and Geoffroy St. Hilaire consider the differences in the osteology, dentition and outward characters of the gorilla to be of generic importance and enter it in the zoological catalogue as *Gorilla gina*, the specific name being that by which the beast is known and dreaded by the natives of Gaboon. The French naturalists also concur with the American in placing the gorilla below the chimpanzee in the zoological scale, and some have lately been disposed to place both below the hylobates or long-armed apes.

Deferring the discussion of these questions, the author proceeded to describe the external characters of the adult male gorilla as they were exhibited by the specimen preserved in spirits. He first called attention to the shortness, almost absence, of neck, due to the backward position of the junction of the head to the trunk, to the great length of the cervical spines, causing the "nape" to project beyond the "occiput," to the great size and elevation of the scapulæ, and to the oblique rising of the clavicles from their sternal attachments to above the level of the angles of the jaw. The brain-case, low and narrow, and the lofty ridges of the skull, make the cranial profile pass in almost a straight line from the occiput to the superorbital ridge, the prominence of which gives the most forbidding feature to the physiognomy of the gorilla; the thick integument overlapping that ridge forming a scowling pent-house over the eyes. The nose is more prominent than in the chimpanzee or orang-utan, not only at its lower expanded part, but at its upper half, where a slight prominence corresponds with that which the author had previously pointed out in the nasal bones. The mouth is very wide, the lips large, of uniform thickness, the upper one with a straight, as if incised margin, not showing the coloured lining membrane when the mouth is shut. The chin very short and receding, the muzzle very prominent. The eyelids with eye-lashes, the eyes wider apart than in the orang or chimpanzee; no eye-brows; but the hairy scalp continued to the superorbital ridge. The ears smaller in proportion than in man, much smaller than in the chimpanzee; but the structure of the auricle more like that of man: it was minutely described and compared. On a direct front view of the face, the ears are on the same parallel with the eyes. The teeth had been described in the author's first paper on the subject (1848, *Trans. Zool. Soc.*). The huge canines in the male give a most formidable aspect to the beast: they were not fully developed in the younger and entire specimen, now mounted. The profile of the trunk describes a slight convexity from the nape to the sacrum,—there being no inbending at the loins, which seem wanting: the thirteenth pair of ribs being close to the "labrum ilii." The chest is of great capacity; the shoulders very wide across; the pectoral regions are slightly marked, and show a pair of nipples placed as in the chimpanzee and human species. The abdomen somewhat prominent, both before and at the sides. The pelvis relatively broader than in other apes.

The chief deviations from the human structure were seen in the limbs, which are of great power; the upper ones prodigiously strong. The arm from below the short deltoid prominence preserves its thickness to the condyles; a uniform circumference prevails in the fore-arm; the leg increases in thickness from below the knee to the ankle: there is no "calf." These characters of the limbs are due to the general absence of those partial muscular enlargements which impart the graceful, varying curves to the outlines of the limbs in man; yet they depended, the author remarked, rather on excess, than defect, of development of the carneous as compared with the tendinous parts of the limb-muscles, which thus continue of almost the same size from their origin to their insertion; with a proportionate gain of strength to the beast. The length of the upper limbs, as compared with the trunk, is not much greater than in man: they seem longer through the disproportionate shortness of the lower limbs. What the author deemed most significant of the anthropoid affinities of the gorilla, is the superior length of the arm to the fore-arm, as compared with the proportions of those parts in the chimpanzee. In that ape the humerus and ulna are of nearly equal length: in the orangs and inferior simiæ the fore-arm exceeds the arm in length. The thumb of the gorilla reaches to beyond the first joint of the forefinger, but it does not extend to that joint in the chimpanzee or other ape: the philosophical zoologist would discern much significance in this fact. In man the thumb extends to beyond the middle of the first "phalanx" of the forefinger. The fore-arm in the gorilla passes into the hand with very slight contraction at the wrist, the circumference of which was 14 inches. The hand is remarkable for the breadth, thickness, and great length of the palm; the latter due both to the length of the metacarpus and unusual extent of undivided integument between the fingers, which begin to be free only towards the end of the first phalanges. The fingers, consequently, seem short, and as if swollen, conical in shape, and tapering quickly at the ends, to the nails, which are not larger or longer than in man. The circumference of the middle finger was 5¼ inches, the same part in man averaging 2¾ inches. The skin covering the back of the middle phalanx, and hiding the joint between that and the last phalanx, is thick and callous, betraying the habit of the animal to apply the knuckles to the ground in occasional progression. The back of the hand is hairy as far as the division of the fingers: the palm naked and callous. The thumb is scarcely half so thick as the forefinger. In the hind-limbs the author began by calling attention to the first appearance in the quadrumanous series of a development of the glutæi muscles causing a small buttock to project over each tuber ischii: this structure, with the expansion and concavity of the iliac bones, peculiar to the gorilla among quadrumana, indicated that it resorted occasionally to standing and walking on the lower limbs, as a biped, with less difficulty and disadvantage than in the lower apes. The leg is not only without that partial accumulation of the fibres of the gastrocnemii forming the "calf;" but, owing to the addition of fleshy fibres to the tendo Achillis as low as the heel, and to a like addition to tendons of muscles passing to the foot, the leg grows thicker from the knee to the ankle. The foot has a peculiar and characteristic form owing to the modifications favouring bipedal progression being superinduced upon an essentially prehensile and quadrumanous type. The heel makes a more decided backward projection than in the chimpanzee; the heel-bone is relatively thicker, deeper, and more expanded at the end, and is shaped more like the human calcaneum than in any other known ape. Although the foot is articulated to the leg with a slight inversion of the sole, it is more nearly plantigrade than in the chimpanzee or any other ape. The "hallux" (hind-thumb or great toe), though not relatively longer, is stronger than in the chimpanzee; it stands out like a long and large thumb from the rest of the foot: its base swells below into a kind of ball; the nail is small and short. The sole of the foot expands from the heel forward to the divergence of the hallux, and here appears as if pretty equally cleft between the base of the hallux and the common base of the other four toes. These are small and slender in proportion, and their first joints are enveloped in a common tegumentary sheath. A longitudinal indent at the middle of the sole bifurcates as it advances, one division defining the ball of the hallux, the other tending toward the interspace between the second and third toes; this indent or groove bespeaks the strong and frequent action of opposition of the thumb, or inner division of the sole to the outer division terminated by the four short toes. The whole sole is wider than in man—much wider in proportion to its length,—more like a hand, but one of huge dimensions and with a portentous power of grasp. It corresponds with what the negroes of the Gaboon narrate:—that the gorilla, letting down his hind hand from his leafy concealment, upon an unsuspecting passer-by, grasps him round the neck, draws him up with ease, and having strangled the negro in his unrelaxing grasp, drops him a corpse! They dread the gorilla's strength and tusks much more than the lion's, and regard the huge ape as their sole truly formidable enemy during their expeditions in quest of ivory in the trackless forests inhabited by the gorilla. Yet the gorilla is evidently, by the structure of the grinding teeth, frugivorous.

Professor Owen next proceeded to give a minute account of the colouration and disposition of the hair in the *Troglodytes gorilla*, showing that, when alive, its coat must reflect a lighter colour than in the *Troglodytes niger*, and a different one, approaching to a dark greyish-brown, some reddish and greyish hairs being blended, in different proportions at different parts, with the general dusky-coloured hairs. The adult male gorilla, in as nearly an upright position as its frame will naturally admit, measures 5 feet 6 inches from the sole to the vertex; the breadth across the shoulders is nearly 3 feet; the length of the upper limb is 3 feet 4 inches; the length of the head and trunk 3 feet 6 inches; the length of the lower limb, from the head of the femur, 2 feet 4 inches; other admeasurements were appended to the paper. The author then entered upon a discussion of the affinities and place in the natural scale of the gorilla. At the first aspect, it strikes the observer as being a more bestial or brutish animal than the chimpanzee; all the features relating to the wielding of the strong jaws and large canines are exaggerated; there appears to be less brain,—its case is more masked by the strong intermuscular crests. But this impression is given more strongly in comparing a young chimpanzee with an old one, or a full-grown monkey of a small species with the large gorilla, orang, or chimpanzee. The difference between the adult gorilla and chimpanzee, in the above respects, is exactly of the same kind and value as the difference between young and old apes—between small and great quadrumana. The small species of every natural group of mammals retain more of the embryonic or immature characters than the great species do; especially as relates to the size of the eyes and brain, and to the proportions of the orbits and brain-case to the jaws and teeth. The characters which, in reference to the question of proximity to man, Professor Owen deemed of real importance to compare in the gorilla and chimpanzee were:—the "mastoid processes;" the "premaxillary portion of the upper jaw;" the "relative size of the incisors to the molars;" the form of the "orbits," and proportion of interorbital space; the "vaginal process of the tympanic bone;" and the "shape of the lower part of the auditory tube;" the "nasal bones;" the "relative length of the arm to the fore-arm;" the "relative length and strength of the thumb;" the "relative length of the upper limb to the entire animal;" the "breadth and configuration of the pelvis;" the "size and shape of the heel-bone;" the "length and strength of the hallux." In all the above points of comparison, the gorilla was shown to resemble the human organization much more, and more decidedly, than does the chimpanzee.

Reverting finally to the ancient notices which might relate to the great anthropoid ape of Africa which had been described, Professor Owen referred to his first Memoir, of February, 1848, in which was quoted (*Trans. Zool. Soc.*, vol. iii. p. 418) Dr. Falconer's *Translation of the Voyage of Hanno* (London, 1797), with his Dissertation vindicating the authenticity of the *Periplus*. Professor Owen had lately been favoured by the venerable Bishop Maltby—the first amongst our Greek scholars—with the following translation of the passage supposed to allude to the species in question:—"On the third day, having sailed from thence, passing the streams of fire, we came to a bay called the Horn of the South. In the recess there was an island like the first, having a lake, and in this there was another island full of wild men. But much the greater part of them were females, with hairy bodies, whom the interpreters called 'Gorillas.' But, pursuing them, we were not able to take the males; they all escaped, being able to climb the precipices, and defended themselves with pieces of rock. But three females, who bit and scratched those who led them, were not willing to follow. However, having killed them, we flayed them, and conveyed the skins to Carthage. For we did not sail any further, as provisions began to fail." This encounter indicates, therefore, the southernmost point on the west coast of Africa reached by the Carthaginian navigator.

To the inquiry by Bishop Maltby, how far the newly-discovered great ape of Africa bore upon the question of the authenticity of the *Periplus*, Professor Owen had replied:—"The size and form of the great ape, now called 'Gorilla,' would suggest to Hanno and his crew no other idea of its nature than that of a kind of human being; but the climbing faculty, the hairy body, and the skinning of the dead specimens, strongly suggest that they were large anthropoid apes. The fact of such apes having the closest observed resemblance to the negro, being of human stature and with hairy bodies, still existing on the west coast of Africa, renders it highly probable that such were the creatures which Hanno saw captured, and called 'Gorullai.'"

The brief observation made by Battell in West Tropical Africa, 1600, recorded in Purchas's *Pilgrimages, or Relations of the World*, 1748, of the nature and habits of the large human-like ape which he calls "Pongo," more decidedly refers to the gorilla. Other notices, as by Nieremberg and Bosman, applied by Buffon to Battell's pongo, were deemed valueless by Cuvier, who altogether rejected the conclusions of his great predecessor as to the existence of any such ape. "This name of Pongo or Boggo, given in Africa to the chimpansee or to the mandrill, has been applied by Buffon to a pretended great species of orang-utan, which was nothing more than the imaginary product of his combinations." After the publication of the *Règne Animal*, the supposed species was, by the high authority of its author, banished from natural history; it has only been authentically reintroduced since the intelligent attention of Dr. Savage to the skull which he first saw at the Gaboon in 1847, and took Professor Owen's opinion upon.

The above paper was illustrated by life-size drawings of the gorilla and chimpanzee, executed with accuracy and vigour by Mr. Joseph Wolf; also by diagrams of the skeletons of the anthropoid apes and man, by Messrs. Scharff and Erxleben.—*Athenæum*, No. 1260.

EARED SEAL.

DR. GRAY has read to the Zoological Society a paper "On the Eared Seal of the Cape of Good Hope." At the previous meeting he gave an account of the eared seal from Behring Straits, showing that it was distinct from the species found in other localities, since which he had received from Paris a fine specimen of an adult eared seal from the Cape of Good Hope, which has been described in the catalogue of the British Museum as *Olaria Delalandii*. Like the seal from Behring Straits, it proves a species of *Arctocephalus*, and like it, it is quite distinct from any of the species of that genus in the British Museum. It is also, like that from Behring Straits, a fur seal, that is to say, it has a close coat of red under-fur, at the roots of the rigid flattened hair; but this under-fur is much shorter and less abundant in the adult specimen now under examination, than in that from Behring Straits, or from the Falkland Islands. It is about the same size as the seal from the Arctic Circle, but is much paler in its general colour.

THE KIANG, OR WILD HORSE OF THIBET.

THROUGH the exertions of Major W. E. Hay, late of the Indian service, the Zoological Society of London have obtained a fine female Kiang, which has been engraved in the *Illustrated London News.* A cursory examination of the animal is sufficient to show its distinctness from all other known varieties of the horse kind. Its larger size and the deep red colour of the face, and darker flanks and back, distinguish it from its nearest relative, the hemoine of Cutch, as well as the narrowness of the dorsal stripe, which in the hemoine is always much broadened towards the tail. Major Hay obtained the animal when quite young from the Zông-pûn or Chinese Governor of Rûdogh, a fort situated beyond the Pâng-Kông Lake in Little Thibet.

Major Hay informs us that the kiang mares are highly esteemed by the Thibetans, and it is with difficulty that they are persuaded to part with them. The half-bred between them and the thorough-bred Chinese horse are valued, as possessing high qualities of endurance, and are on that account much used by the Zhakpas, a race of hill robbers who inhabit those mountains.

The fine collection of wild horses now in the Zoological Society's Gardens embraces the zuagga, Burchell's zebra, the hemoine, the hemippe, and the kiang, all arranged side by side, so that their differences and peculiarities may be readily compared.

QUALITY OF ELAND MEAT.

PROFESSOR OWEN writes to the *Times:*—I send you the experience of a "committee of taste," including three brother naturalists, who sat down to test the qualities of a joint of Eland, the first of that fine species of antelope which has been fattened and killed for the table. I may premise that the eland (*Antilope Oreas,* Pallas) is one of the largest of its genus, equalling an ox in size, but standing higher, a native of South Africa. The species was first imported into this country by the late Earl of Derby. The pair throve and propagated in the park at Knowsley, and at the decease of the earl formed a small herd, which his lordship bequeathed to the Zoological Society of London. They throve equally well, and continued regularly to produce young in the gardens at Regent's Park, until their numbers began to exceed the accommodation.

Among the noblemen and gentlemen who were willing to co-operate with the Society in the attempt to acclimatize and diffuse this fine and beautiful animal, Viscount Hill has had such success with the pair which was introduced into his park at Hawkstone, near Shrewsbury, that his lordship determined to make the experiment and fatten a young male for the table. The result now communicated was obtained from a joint answering to the "short ribs" of beef, with which the writer was liberally favoured by Lord Hill. The meat was of a bright colour and of a close, fine texture, but without any fat mixed with the lean. A good quantity of fat was accumulated round the kidney and upon the inside of the ribs. After hanging ten days the joint was simply roasted, with a part of the loin-fat or suet, another part of this being made into a suet-pudding. The meat when brought to table and carved presented the colour of pork. Committee unanimous as to its texture—the finest, closest, most tender, and masticable of any meat. In taste, the first impression was of its sweetness and goodness, without any strongly marked speciality of flavour; it was compared with veal, with capon; finally, the suggestion that it was (*mammalian*) meat, with a *soupçon* of pheasant flavour, was generally accepted. Committee unanimous that a six-year-old eland would most probably yield a meat equally fine in texture, with a more marked and distinctive flavour; and that the extreme delicacy of flavour might be due to the immaturity of the present animal. The portion of fat served with the joint differed from that of deer in not rapidly condensing into tallow, but retaining, like the best beef fat, its clear melting character; it was perfection as fat. Suet-pudding extremely light and delicate. And, on the whole, the committee rose with the conviction that a new and superior kind of animal food had been added to the restricted choice from the mammalian class at present available in Europe.

NEW BIRDS.

MR. GOULD has exhibited and described to the Zoological Society two new species of Birds, one belonging to the family *Cuculidæ*, the other to the *Coturnicæ*. These birds are very remarkable, as forming probably the smallest species of the groups to which they respectively pertain. For the cuckoo which was killed at Port Essington, on the north coast of Australia, Mr. Gould proposed the name of *Chrysococcyx minutillus*; and the quail which belongs to the genus *Excalfatoria* of Bonaparte he characterized as *Excalfatoria minima*. Mr. S. Stephens has read an extract from a letter received by him from Mr. A. R. Wallace, dated Batchian, Moluccas, October 29, 1858, in which Mr. Wallace stated that he had the finest and most wonderful bird in the islands—a new bird of Paradise, of a new genus, quite unlike anything yet known. Mr. Wallace enclosed a rough sketch of the bird. Mr. G. R. Gray having had the above sketch placed in his hands for examination and comparison with the other known species of *Paradiseæ*, agreed with Mr. Wallace that it is an entirely new form, differing from all its congeners, approaching most nearly to the king bird of Paradise, but in place of the lengthened caudal appendages, it has springing from the lesser coverts of each wing two long shafts, each being webbed with white on each side at the apex. The possession of these peculiar winged standards induced Mr. G. R. Gray to propose the subgeneric name of *Semeioptera*, and he further added the provisional specific name of *Wallacei*, in commemoration of the indefatigable energy Mr. Wallace had hitherto shown in the advancement of ornithological knowledge. Mr. G. R. Gray laid before the meeting a drawing of *Tringa pectoralis* made by the late Mr. Adams, surgeon of H.M.S. *Enterprise*. It exhibits the bird in the act of having inflated its throat and breast in the manner of the pouter pigeon—a habit in all probability peculiar to the breeding season; as the drawing was dated June 1, 1854.

Mr. Gould has also exhibited the following :—

Specimens of a new species of Odontophorus, discovered in Ecuador, by Mr. Fraser, and which he named *O. erythrops;* and the description of a species of Rupicola, from Ecuador, which he considered new, and for which he proposed the name of *R. sanguineolenta.*

A new species of Dendrochelidon, or Tree-Swift, discovered by Mr. Wallace, in Macassar, to which he gave the name of *D. Wallacei*, in honour of its discoverer.

Mr. Gould next read a paper containing a "List of Birds from the Falkland Islands, with Descriptions of the Eggs of some of the Species." Included in the list was a specimen of a gull, which Mr. Gould described as new, with some degree of hesitation, under the name of *Gavia roseigaster.* The hind toes of this the only specimen Mr. Gould had ever seen, were well developed, but entirely *destitute of nails.*

Mr. Gould also exhibited a specimen of *Crithagra Brasiliensis*, a native of Brazil, forwarded to him by Mr. Stone, of Brighthampton, which was shot in October last, at Bampton, Oxon, whilst in company with a flock of sparrows. Mr. Gould considered it had most likely been in confinement, but had evidently moulted while free.

THE LITTLE BUSTARD.

In October last, a fine specimen of the Little Bustard (*Otis tetrax*) was shot in the neighbourhood of Oxford, by the Rev. F. Burgess, Fellow of St. John's College, Oxford. This rare straggler is now in the hands of Mr. Osman, bird-preserver, of that city, who has pronounced it to be a young bird of the male species. The last Little Bustard on record killed in this county was shot on Denton-common, near Oxford, in December, 1833.

SPARROWS FOR NEW ZEALAND.

It appears that in New Zealand the country, at particular seasons, is invaded by armies of caterpillars, which clear off the grain crops as completely as if mowed down by a scythe. With the view of counteracting this plague, a novel importation has been made. It is thus noticed by the *Southern Cross* :—"Mr. Brodie has shipped 300 Sparrows on board the *Swordfish* carefully selected from the best hedgerows in England. The food alone, he informs us, put on board for them cost 18*l*. This sparrow question has been a long-standing joke in Auckland; but the necessity to farmers of small birds to keep down the grubs is admitted on all sides. There is no security in New Zealand against the invasion of myriads of caterpillars which devastate the crops. Mr. Brodie has already acclimatized the pheasant, which is abundant in the north. The descent from the pheasant to sparrows is somewhat of an anti-climax; but should the latter multiply the greatest benefit will have been conferred on the country."—*Australian Mail.*

NEW PHEASANTS.

MR. GOULD has read to the British Association a paper "On the Varieties and Species of New Pheasants recently introduced into England." After a sketch of the distribution of the family of Gallinaceous birds, the author gave an account of the species of Phasianus (Pheasant), which had been introduced into England. All the species are from Asia. The oldest English species is the *P. Colchicus*, which is from Asia Minor. The next is *P. torquatus*, from Shanghai, which was introduced about one hundred years ago, and has recently been reintroduced. Specimens of this kind reared in Bedfordshire were exhibited. The crosses between these two birds produce remarkably fine and strong birds. The other true species are *P. Mongolicus* from Mongolia, *P. Lœmmenigii* from Japan, *P. Reevesii* from China, and *P. versicolor* from Japan. *P. Reevesii* is remarkable for a tail six feet in length; whilst the last species has been successfully introduced into England, and bred freely with *P. Colchicus*, and the crosses between that bird and *P. torquatus*; and the result has been greatly to improve the strength and weight of the birds.*

THE HERRING.

MR. J. M. MITCHELL, in a paper communicated to the Royal Society of Edinburgh by Dr. Allman, before entering on the details of the natural history of the Herring, points out the great value of the herring-fishery to the maritime nations of Europe; and quotes various scientific authorities to show, that the herring is superior in economical importance to every other fish. Thus Cuvier, in his work on fishes, edited by Professor Valenciennes, says,—"Les grands politiques, les plus habiles economistes ont vu dans la peche du hareng la plus importante des expéditions maritimes."

Such views have led the British, Dutch, Swedish, and Norwegian governments to inquire at present into the natural history, and to legislate regarding the fishery of the herring. The author has described the principal steps taken by these nations, and has given important statistical details of the British herring fishery, showing that fish, to the value of upwards of a million sterling, are annually taken on our coasts.

The high value of the fishery, not only in promoting the welfare of a large portion of our population, but in producing a strong, hardy, and industrious race of fishermen, most valuable to such a maritime nation as Britain, is next referred to.

The author then points out various errors regarding the herring which have been committed in works of high authority, such as Cuvier's work on fishes, already referred to, M'Culloch's *Dictionary of Commerce*, and the last edition of the *Encyclopædia Britannica*. He conceives that he has solved the doubtful questions regarding the natural history of the herring,—an object of the greatest importance when we consider the high economical value of the fishery. He also points out several new and important facts regarding the appearance of the fish on our coasts. Among others, that the herring swims nearest the surface in dark and wild weather; and nearer the bottom when the weather is bright and cold.

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* The reader will, we dare say, thank us for directing his attention to an admirable paper entitled "The New Pheasants," in No. 201 of the *Saturday Review*, which details the acclimatation of these valuable birds from Japan, China, and India,—in a contribution to zoological science, at once sound and attractive.

He next enters on the details of the natural history of the herring, describing its characteristics and its distinctive difference from other fishes of its class. The important question of its food is elaborately examined; and it is shown, as stated to the author by Agassiz, that the herring does not confine itself to one species of food, namely, that the food usually consists of minute crustacea; but during the spawning season it feeds on sand-eels, the fry of various fishes, and even its own spawn.

The author has ascertained a new and important fact from personal observation, regarding the cohesion of the spawn, and the power of adhering strongly to substances on which it may be placed, which only takes place on the fecundation of the roe by the milt.

Many writers reiterate the opinion, that the herring is a native of the distant northern seas. This the author shows to be an error, proving that the fish is a permanent inhabitant of our coasts.

He, for the first time, gives a complete description of the visits of the herring, or its geographical and chronological distribution over the surface of the globe, so far as is known; and his work is the first and only one which exhausts the difficult questions which have hitherto arisen regarding the most valuable and important fish which the bounty of Providence sends to supply food for the human race. —*Edinburgh New Philosophical Journal*, No. 19.

SALMON FOR AUSTRALIA.

The Royal Society of Tasmania has unanimously agreed to give 500*l*. to any person who will introduce five pairs of live full-grown salmon into that colony. They are also prepared to give at the rate of two pounds per pair for salmon smolts and one pound per pair for salmon fry. Beyond this, the government of Tasmania is prepared to expend several hundreds of pounds in forming ponds and channels for the reception of the noble fish. There are unquestionably great difficulties to be overcome before this particular description of fish will be familiar to the epicures of Hobart Town. Salmon, although one of the most migratory fishes, does not seem up to the present time ever to have crossed the line. It is known to almost every part of Europe and North America, and traverses the longest rivers in order to find a suitable breeding-place. It passes down the Elbe to reach Bohemia, down the Rhine to get to Switzerland, and reaches the Cordilleras by the Amazon, and various inland parts of Canada and the United States by the St. Lawrence and other large rivers. There was a time when the royal fish visited the neighbourhood of Windsor by the Thames; forty years have passed, it is said, since the last salmon that ventured up our river was captured. It was discovered by some fishermen, who after great perseverance succeeded in taking it; and the last salmon from the Thames formed "a dainty dish to set before the king," who gave the lucky netters a guinea a pound, or twenty guineas for their prize. The refuse of gas-works and the offensive outpourings of sewers and other abominations of manufacturing establishments, have driven the salmon from the Thames.—*Australian and New Zealand Gazette.*

"FISH-RAIN."

At the late meeting of the British Association, the Rev. W. S. Symonds gave an account of the Fish-Rain at Aberdare, in Glamorganshire. The evidence of the fall of fish on this occasion was very conclusive. A specimen of the fish was exhibited, and was found to be the common stickleback. A discussion ensued, in which various cases were related of the transference of living objects by the agency of the whirlpools produced by storms.

THE ELECTRICAL EEL.

Dr. G. Wilson has read to the British Association, a paper "On the Employment of the Electrical Eel (*Gymnotus electricus*) by the Natives of Surinam." After alluding to the paper he had read at the last meeting of the Association on the electrical Melapterurus from Old Calabar, the author gave an account of the employment of the Gymnotus, in Surinam, as a medicinal agent. He had obtained his information from a gentleman who had expressed his willingness to forward to England living specimens of this electrical fish for experiment.

Mr. A. Murray remarked on the difficulty of bringing over these fish alive, and mentioned several instances in which they had died on the voyage, especially when they arrived in the Channel. This discussion resulted in the formation of a Committee of the Section to draw up directions, in order to guide those who were engaged in transporting these fish from their native haunts to Great Britain.

AGED ACTINIA.

Dr. M'Bain has communicated to the British Association a "Notice of the Duration of Life in the *Actinia mesembryanthemum*, when kept in confinement." The author exhibited a specimen of the *A. mesembryanthemum* which had been in the possession of Sir J. Dalyell and Dr. Fleming for thirty-one years. The exhibition of this now celebrated Actinia produced great interest in the Section.

NEW LUCEMARIADA.

Professor Allman has described to the British Association a new genus of Lucemariadæ. This creature is a kind of fixed Medusa, having a structure resembling many of the common forms of floating Jelly Fishes, but is fixed to rocks by means of a pedicle or stalk. It has been found on the more northern shores of Scotland, and Professor Allman proposed for it the name of *Carduella Scoticus*. Mr. Peach has found this creature under stones in Caithness. He states, as a curious fact, that many creatures which he has observed in the deep sea off the coasts of Cornwall are littoral on the shores of Scotland.

NUDIBRANCHIATE MOLLUSKS.

Mr. J. Williams writes to the *Athenæum*, No. 1646:—"A month or two ago I obtained a specimen of *E. papillosa*, about two inches long; it was then salmon-coloured, freckled as usual. After being for some weeks in my tank, the animal fastened like a leech upon a common scarlet *Actinia mesembryanthemum*, attached to whom it remained for three days. At the expiration of that time the Actinia was shrivelled up and dead, and the Eolis had become of a deep crimson colour, papillæ and all. During the three weeks which have elapsed since this happened, the animal has been gradually regaining his former colour, and is now once more dingily salmon-coloured. Every fragment of effete matter which has during this period been discharged from it has the colour and appearance of an *unchanged* fragment of the crimson Actinia. I do not find this peculiarity of changing colour mentioned in Alder and Hancock, or in any other work with which I am acquainted."

MARINE AQUARIA.

Mr. W. Alford Lloyd has communicated to the *Athenæum* a few of the results of his professional experience in the construction and management of the Marine Aquarium, which, he maintains, is unworthily represented in every establishment, whether in the hands of private persons, or belonging to Societies, or under the auspices of Government. Even the tank-house of the Zoological Society of London, in Regent's Park, is no exception to this statement, for the arrangements there adopted are now, confessedly, very ill designed for the purposes in view. It was built under the superintendence of the late Mr. D. W. Mitchell, at a time when very little was known about the subject; and no precedent existed for anything of the kind. Certain plants were known to give off a supply of oxygen while under the stimulus of light, and this oxygen was known to be required by the animals associated with the plants; and thus it was imagined that if a collection of any living vegetables and creatures were placed together in any vessel, they would at once, and with scarcely any trouble, be rendered mutually self-supporting. It was soon found out, however, that this crude theory required to be modified to so great an extent, and that it demanded to be associated with so many other conditions, that the conservatory-like building now standing in the Gardens was discovered to be, in the first summer of its existence, an arrangement so utterly wrong, that the modifications it demanded would amount to something like an entire reconstruction. This was because of the acceptance, exclusively, and in too great a latitude, of the old formula of *plenty of light;* forgetting, however, how small is the amount of illumination obtained by plants and animals in the sea, and quite overlooking the fact that, out of the sea, and upon land, a great amount of light is usually accompanied by much *heat*, while, in the ocean, the temperature around

Britain does not vary, at any season, much from 60° Fahr. In the fish-house of the Zoological Society, however, the range is, or may be, from about 30° to upwards of 90°. On the 13th of July last, at four o'clock in the afternoon, the thermometer in the *house* stood at 98°, and in the *tanks*, with a free bulb immersed in the water, it was 82°. Nothing in the shape of animal life, planned by nature for an equable and moderate temperature, can long resist the destructive effects of such a heat as *that*, or, if some of the hardier kinds *do* manage to exist in it, their health is surely deteriorated. Then, the result to the vegetation is equally disastrous. Natural water, and especially sea-water, is so full of germs of plant life, that, when such water is exposed to light, the minute locomotive plants of the humbler kinds, or the spores of the higher plants, are rapidly called into visible existence, and if the exposure to light and heat be long continued, the water becomes so full of these atoms as to assume a dense and opaque greenish-brown colour, rendering all within the aquarium invisible, or nearly so. A few summers ago, the excessive amount of light was in some measure subdued by a covering of tarpaulin, though the heat continues, as before shown, nearly as great as ever.

But another radical defect then became apparent—namely, the too great height and too narrow breadth of the tanks themselves, the result of this being that the surface of water presented to the oxygen of the atmosphere was disadvantageously little—so little, indeed, that it may be fairly calculated that not more than 30 per cent. of the bulk of fluid employed is rendered available for the animals kept in it, and the means do not exist of re-supplying oxygen as fast as it is consumed. It seems to be not remembered that the oxygen derived from growing plants is serviceable as an auxiliary only to the oxygen obtained directly from the surrounding air, and that the attainment of this last-mentioned condition must depend mainly upon the form and proportions of the tanks adopted, and should therefore be a primary, and not, as at present, a secondary consideration, and the consequences of the neglect of this law are, that only a certain limited number of slow-breathing animals can be permanently maintained, and that a vain attempt is constantly being made to keep other and more numerous and more highly-organized creatures by a weekly change of sea-water (in most of the larger tanks), throwing away the old water and supplying a new lot. Now, this is a piece of tremendous extravagance; and it becomes simply a matter of figures to show how the hundreds of pounds thus spent idly and fruitlessly by the Society in the last seven years might have been expended in building another and a better aquarian house. Sea-water never becomes deteriorated in any way by any amount of using or keeping or filtering; so far from that, indeed, it improves by age, and therefore, had it been thought of, the couple or three thousand gallons or so, purchased for the Gardens in 1853, might have been in use up to this hour, without diminution of volume or alteration of any of its qualities for aquarian purposes. Of course, no one is to be blamed for all this, nor yet for the corresponding paucity of specimens incidental to the system, because no one pointed out the evil till the mischief was done; yet, now that the thing is so apparent, steps should be taken to remedy it.

NEW CLASSIFICATION OF REPTILES.

PROFESSOR OWEN has read to the British Association a paper "On the Orders of Fossil and Recent Reptiles, and their Distribution in Time." In this communication, the author "has developed his new stand-point in Natural History. The sub-class of reptiles, which was formerly divided into four orders, the Professor now proposes to divide into thirteen. This revision has resulted from the study of the fossil forms which have been found in such abundance in the secondary strata of the earth's surface. At the head of the reptile orders he places an extinct form—Archegosaurus—and in the lowest order the Batrachian reptiles (the toads and frogs). He still retains these amongst the reptiles, on account of the difficulty of distinguishing between them and the Chelonia, or tortoises and turtles. At the same time the Professor acknowledges his inability to distinguish between the Batrachia and the next group of animals, the fishes. The whole paper will be read with deep interest by the zoologist; and it cannot fail to add to the great reputation of the author as a systematist and comparative anatomist."—*Athenæum*. (See No. 1666 for the entire paper.)

The following is the summary of the defined orders:—

Province—VERTEBRATA. *Class*—HÆMATOCRYA. *Sub-Class*—REPTILIA.

Orders.

I. Ganocephala.
II. Labyrinthodontia.
III. Ichthyopterygia.
IV. Sauropterygia.
V. Anomodontia.
VI. Pterosauria.
VII. Thecodontia.
VIII. Dinosauria.
IX. Crocodilia.
X. Lacertilia.
XI. Ophidia.
XII. Chelonia.
XIII. Batrachia.

Professor Huxley thought this communication a most important contribution to science. He quite agreed with Professor Owen in placing together the amphibia and fishes, as no real distinction could be drawn between them. It was, however, different with the true reptiles and amphibia, although Professor Owen was not disposed to attach importance to these distinctions. The amphibia possessed no allantois and had gills, points of structure which separated them strongly from the true reptiles. Amongst extinct animals none presented any transitional forms. Professor Owen defended his own position on the ground, that such an interpretation could be given to the allantois on the one side and the gills on the other as to render the distinctions less obvious than at first sight appeared.

THE SALAMANDER.

THE menagerie at the Jardin des Plantes has been enriched by the reception of a fine specimen of the *Salamandra Maxima*, or large Salamander of Japan. This reptile has been sent by M. de [illegible], French Consul-General in the Dutch East India Colonies, as a present from M. Pompe van Meedervoot, physician to the Dutch Government at Japan. Up to the present time there have been only two living specimens in Europe, one at Leyden and the other at Amsterdam. The salamander, which has only been known to Europeans since the tour of discovery made in Japan by M. de Siebold, lives in the mountain valleys of the Isle of Niphon, between the 34th and 36th degrees north latitude. It resides in the rivulets and lakes formed by the rains, at a height of from 4000 to 5000 feet above the level of the sea. This reptile arrived in Paris from Batavia, after a voyage of two months, and, although it suffered a little during the passage, it appears now in excellent health. It is about 27½ inches in length, and when full grown will be about 3 feet.

ANTIDOTE FOR SNAKE BITES.

In the *Melbourne Examiner*, of the 14th of May last, is an account of a public trial of the value of an antidote for snake bites, said to be known to a Mr. Underwood. The experiments were made in the rooms of Messrs. Easey and Co., auctioneers, Collins-street, in the presence of about 500 spectators. The snakes employed by Mr. Underwood were a whip-snake, about 15 inches long, and two diamond snakes, one about 20 inches, the other 3½ feet in length. The larger of the diamond snakes Mr. Underwood provoked till it bit himself on the lower part of the fore-finger. A rabbit was bitten several times by the whip-snake, but neither the rabbit nor Mr. Underwood appeared to be in any way inconvenienced by the bites. The experiments were declared, however, not to have been satisfactory, and the secret of the antidote was not revealed.

In another page of the same journal is inserted the following extract from the *Hobart Town Mercury* :—

> "According to the *Cornwall Chronicle*, 'the secret so long confined to the heart of Underwood,' in reference to his antidote to the bite of snakes, has at length been discovered, and the common male fern—*polypodium filix mas*—is stated to furnish the remedy. This very common plant has been long known as a specific in the cure of worms, especially the tapeworms—the powdered root being generally used for this purpose ; but from circumstances which have transpired it would appear that Underwood uses a decoction, or broth, of the leaves near the root as being stronger, perhaps, than those near the apex of the plant, We believe in the efficacy of this remedy, which may be easily tested by experiments on animals, and its power might perhaps be augmented if used in the form of a tincture—that is, with an ounce of the leaves steeped for a fortnight in a pint of rum, or brandy, in which state it could be kept for any length of time, if well corked, without deterioration by fermentation or otherwise. The fern is common in all parts of the island, and may be gathered at any time, so that an antidote so serviceable may be in the hands of every one."

JAPANESE WAX.

Professor W. B. Rogers states that the Japanese Wax, though as white as bleached bees-wax, at ordinary temperatures, is more brittle, less ductile, and breaks with a smoother and more conchoidal fracture ; its specific gravity is slightly less, and its melting-point about 127°. Like bees-wax, it is separable into three fatty bodies, whose proportions in round numbers are, in 100 parts—soluble in cold alcohol (60° F.), 12 parts; in hot, 55 parts; and insoluble in alcohol, 33 parts. Bees-wax similarly treated yields respectively 4 or 5, 22, and 73 or 74 parts of the ingredients, which are called cerolein, cerotic acid, and myricine; the first two fatty acids, and the last a neutral fat compounded of palmitic acid and a fatty base. The three corresponding substances obtained from the vegetable wax differ from the above in their physical properties, and may on examination be found to consist wholly or in part of distinct and perhaps new fatty bodies. In regard to its economical applications, it may be added that the great readiness with which it is saponified, and the clear and strong light which it yields when burned in the form of candles, give promise that it may ere long become an article of considerable commercial importance.—*Proceedings of the Boston Society of Natural History.*

RARE INSECTS.

MR. F. BOND has exhibited to the Entomological Society a remarkable monstrosity of the Death's Head Moth, in which the wings of the right side were difformed, and the veins considerably displaced; also a specimen of *Mythimna turca*, set upside down, in order to display the remarkable structure of the legs of the male. Mr. S. Stevens exhibited a variety of rare coleoptera and lepidoptera, recently received from Mr. Foxcroft, who had collected them at Sierra Leone; likewise a number of minute and very interesting coleoptera, captured by Mr. Wallace, in Celebes, including numerous species of staphylinidæ, which Mr. Wallace stated were as abundant in Celebes as in England. Mr. Wallace exhibited various rare lepidoptera, recently taken by himself, including the new *Laphygma exigua*, which flies to the light at night, and runs about rapidly in the same manner as *Micra ostrina*, *Catephia alchymista*, a species new to the British fauna, taken in the Isle of White, in September; *Acontia luchiosa*, three species of *Nola*, together with *N. centonalis*, new to England, taken in the Isle of Wight in the first week of July. Mr. F. Smith exhibited some curious galls, found on the leaves of beech, which Mr. F. Walker had identified with some recently found by Dr. Ezra Downes, at Fontainebleau, and which had not previously been known as British; also specimens of the works of *Ponera contracta*, a very rare British ant, which he had found running about very actively in a bakehouse. Mr. Westwood exhibited a specimen of the large Indian *Solfuga*, a very ravenous species of spider, communicated by Mr. Albert Waghorn, who stated that it had devoured seven wasps in one night; he also exhibited a minute lepidopterous larva, which had done much injury in the library of a friend, by gnawing the leather binding of the books.

BEE-KEEPING.

MR. TEGETMEYER has described to the Entomological Society, a practical application of Shirach's discovery of the power possessed by Bees of raising a queen from neuter or worker grubs; by means of which the contents of old hives can be taken without destroying the bees or sacrificing any brood. The plan consists in driving out the queen and about half the bees in the spring, and establishing them as a new swarm, when the bees remaining in the old hive have to raise a new queen from a worker grub; from the time required to accomplish this it follows *that no eggs can be laid for about three weeks*; by this time all the worker-producing eggs laid by the old queen will have been hatched out, and the cells filled with honey, when the whole of the bees are to be driven out, and the honey (which by these means will be found perfectly free from brood) retained for use. The plan had been very successfully worked at the bee-house of the Apiarian Society, and specimens of the results were submitted to the meeting.

Mr. Tegetmeyer has also detailed some observations he had lately made, proving that bees resort to a chalybeate spring in preference to those which are not impregnated with iron.

APIARIAN SOCIETY.

THIS newly-formed Society has established an experimental Apiary, under the care of the secretary, at Muswell-hill, to which the public are admitted by members' orders. Numerous donations of books have been received for the library, and it is the intention of the committee to institute lectures on improved methods of bee-keeping, and also to offer prizes to cottagers for the best examples of bee-management. Mr. Tegetmeyer has described an entirely novel method of bee-keeping adopted in America, which the Society are about to test at their apiary.

THE LANTERN-FLY OF HONDURAS.

MR. JAMES BANKS having exhibited, some time since, a specimen of the Lantern-fly, (*Fulgora laternaria*) of Honduras, doubts were cast on Madame Merian's statements as to its being really luminous at times or not, and Mr. Banks was requested to get farther information if possible on the subject. He has received letters from correspondents in Belize, and they bear testimony to the truth of the statement that this fly really emits a light. Mr. Alexander Henderson, Belize, says:—"The fly certainly possesses light, and therefore emits it. The light is evidently under its control, for it increases and diminishes it at pleasure. When the wings are closed, there are three luminous spots, one on each side of the head part, giving out a beautiful sulphur-coloured light, in rays that spread over the room. The third luminous spot is seen when the fly is on its back, half-way down the abdominal part of the insect. When quiescent, the lumination is least; in daylight the upper spots are nearly white, emitting no light whatever (its lively time is at twilight). Immediately on being agitated, or moving about, the spots become sulphur-coloured, and radiate forth streams of light, clearly seen although the sun be shining into the room, as it now does at the moment I write, with the creature in the glass tumbler before me."

BRITISH

MR. H. T. STAINTON has read to the British Association a paper "On the Distribution of British Butterflies."

Among the insect tribes, the "Scale-wings," or order Lepidoptera, has always attracted a considerable amount of attention. The variety and beauty of the butterfly tribe is a matter of notoriety. The order Lepidoptera includes two great divisions, butterflies and moths—the former group all fly by day, whereas most of the moths are nocturnal in their habits. It has been calculated that there are not less than 50,000 different species of Lepidoptera on the globe. More than 3000 species of butterflies are already known, and it has been computed that the moths are sixteen times as numerous. In this country the proportion of moths is much greater, being nearly 30 to 1, but then we are remarkable throughout Europe for our poverty in butterflies. As already observed, in the whole world 3000 species of butterflies are already known, of these only one-tenth occur in Europe, the tropical parts of Asia and America being by far the most numerously populated with this beautiful tribe of insects. In central Europe or Germany, 186 species of butterflies have been observed, the remaining 120 European species being peculiar to Spain, Italy, Greece, Russia, or Lapland. Of the German species 94 occur in Belgium, but only 65 in England, though we possess one species, *Erebia Cassiope*, which does not occur in Belgium. All the British butterflies occur in England, but little more than half (only 33) are found in Scotland, and scarcely more in Ireland. Twenty-five species may be considered as generally distributed and common; but it should not be understood that these are everywhere to be met with, but simply that their geographical range is not limited, and that where they find suitable localities we may expect to meet with them from Norfolk to Killarney, and from the Isle of Wight to Caithness—some frequent gardens, some meadows, some heaths, some woods, and some hedgerows and lanes. Twenty-five other species, which all occur in the south-east of England, thin out as we advance northwards and westwards—only five of them occurring in Scotland, only fourteen in Ireland. Three species, two of which are common in the mountainous parts of Scotland, do not occur at all in the south of England. Seven species are local to particular limited districts in the midland counties or the south of England. Three species of rare occurrence in this country must be looked upon as stragglers from the Continent; one of them, *Vanessa Antiopa*, has occurred in the south-west of Scotland and at Dunbar. Two other species, which formerly occurred in restricted English localities, now appear to be extinct there.—*Athenæum Report.*

MR. ANDREW MURRAY has exhibited to the Royal Physical Society a fine series of Eyeless Beetles from the caves of Carniola and Hungary. Of the 26 different species shown two were new genera—*Pholenon* and *Drimeotus*, which are of special interest, as filling up a blank between the two genera Leptoderus and Adelops, and proving that the former of these genera truly belonged to the family of the Choleoidæ, instead of being allied to the genus Mastigus, as was supposed by Lacordaire and other authors.

CHRONOMETRY OF LIFE.

Mr. Paget, F.R.S., has read to the Royal Institution a discourse, the design of which was to illustrate the law that the processes of organic life are regulated with a regard to time as exact as that which is observed by them in respect of size and weight and quantity of material employed in them; and to show that such an observance of time is characteristic of life, depending essentially on properties inherent in the living bodies themselves, and not on conditions external to them.

Having adduced a great number of examples, Mr. Paget concludes:—

Whatever evidence these and the like facts might supply, that, in connexion with the seasons, the time-rates of the organic processes in the lower organisms are essentially dependent on the inherent properties of each organism, similar evidence might be adduced for the case of the higher, and especially the warm-blooded animals. In these the varieties of seasons have less influence in modifying the rate, as well as all the other measures, of life; and the less influence, the higher the species, or the degree of development of the individual. Moreover, there are in birds some instances in which organic processes have a tendency to observe certain times of the year even when the seasons are changed. Thus among those brought from Australia to this country, some of the parakeets bred here in December; the black swan sometimes breeds in November as well as in May; the New Holland Cereopsis-goose has bred at the Zoological Gardens every February for five or six years.* Among migratory birds, also, it has been observed that when they are kept in confinement, and removed from all the circumstances that might be supposed to induce or necessitate their journeys, they yet become restless at the return of the season for their migration.

In these and the like facts there appear indications of a chronometry in the organic processes of warm-blooded animals, which corresponds with that of the seasons, but is essentially independent. And, if it be so, these might form a group of facts, in addition to those of the diurnal variations of the organic processes, in which vital changes are set to the same rules of time as changes of the surface of the earth, yet have their own proper laws; and concerning which it might be said, that the cycles of life, and of the earth do, indeed, correspond, but only as concentric circles do, which are drawn round one centre, but are not connected, except in design and mutual fitness.

But, however this might be, all the instances of time-regulation cited in the discourse (all being examples of large groups of facts), would seem sufficient to prove, that the observance of time in organic processes is as exact and as universal as that of any other measure; that each species has a certain time-rate for the processes of its life, variable, but not determined, by external conditions; and that the several phenomena commonly studied as the periodicities of organic life, are only prominent instances of the law which it was the object of the discourse to illustrate.

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* Mr. Sclater, to whom the speaker was indebted for this fact, supplied also dates which tend to prove that the Australian parakeets in this country breed less often in December than in the months from May to September, inclusive; but even a minority of instances of the observance of times, and a general tendency towards it, when the force of such external conditions as those of the seasons is strong against it, is good evidence that inherent properties are the mainsprings determining the rates of life.

BOTANY.

GROWTH OF PLANTS.

DR. **LANKESTER** has laid before the section of Zoology and Botany of the British Association a Report from Professor Buckman, "On the Growth of Plants." The Report stated that the author was continuing his experiments on the influence of cultivation in altering the specific characters of plants. Several instances were given in which the character of a plant was so much changed by culture as to lead to the supposition that certain forms which had hitherto been regarded as distinct species were only varieties.

RESPIRATION OF PLANTS.

M. **TRAUBE** has arrived at the following conclusions on the subject:—

1. Plants absorb oxygen, not only during germination, but during all the periods of their growth, and even in sunlight.—(*Saussure*).

2. The absorption of oxygen is absolutely necessary for their development. If they are deprived of this gas, they cease to grow, and soon die.

3. The oxygen which plants absorb in darkness is always converted into carbonic acid. This phenomena also takes place during the day; but the presence of the acid is then detected with difficulty, owing to its decomposition by the green parts of plants.

4. Plants, besides this power of decomposing carbonic acid by means of their green parts, possess a respiration like that of animals. This respiration consists in the absorption of oxygen and the giving out of carbonic acid. It is necessary for the vital activity of their organism.

5. Plants do not possess special organs of respiration.

6. The most important product of plant-respiration is cellulose, which arises from the oxidation of a hydrated carburet, dextrine, glucose, &c.

7. The principal functions of respiration in plants is the organization and elaboration of the nourishing sap—an elaboration which depends on the presence of cellulose. The formation of cellulose is completely independent of solar light. Plants, like animals, are developed also in darkness.

8. The vertical direction seen in the development of the young plants has also no connexion with sunlight.—*Trans. Acad. Science, Berlin.*

VASCULAR BUNDLES OF FERNS.

IT is generally stated that the vessels found in these Bundles are scalariform and pitted vessels. This may be true in regard to the full-grown stem of Tree Ferns, but it is not so in regard to the petioles and the ribs of the young fronds of other fibres. M. Paul Biot says, that if a vertical section is made of the young circinate frond of Polypodium, Adiantum, Pteris, Asplenium, and Dicksonia, there will be seen all kinds of vessels, and among them true unrollable spirals. The extremity of the petiole may be broken in such a way as to have a fragment supported by means of spiral threads, just as happens in the young stem of the vine or the elder. In *Polypodium vulgare* and *Lastrea Filixmas*, these spiral vessels or tracheæ appear the only ones found at the summit of the frond during its early growth. Soon, however, their absolute and relative number diminishes, and annulated, reticulated, and scalariform vessels appear. In the early period of the development, the scalariform vessels are very rare. Their number augments as the tissues become more dense. In the old and fully developed fern-stems, scalariform vessels are almost the only ones found. Even in them, however, we meet with mixed vessels of a spiral and annular kind.—*Proceedings of Philomathic Society of Paris*, July, 1859.

VEGETATIVE AXIS OF FERNS.

Dr. Ogilvie has read to the British Association a paper embracing two principal points—the general form of the Rhizome of Ferns and its internal structure. The stems of our British species, at least, may be reduced to three forms—the creeping Rhizome and the Caudex, branched or simple. We have examples of the first in our Brakens and Polypodes, and of the others in the tufted stem of Blechnum and Osonunda, the lady-fern and its congeners, and the parsley-fern, and in the massive imbricated root-stock of the male fern and some other species of Aspidium. The last form presents many points of similarity to the tree-fern, though its small development and horizontal line of growth prevent its forming any conspicuous trunk above the surface of the ground. The resemblance becomes more apparent when the persistent bases of the decayed fronds are cut off, and only the central axis left, marked by spiral rows of cicatrices like the scars marking the stem of the tree-fern. The chief peculiarity of the *internal* structure is the reduction of the fibro-vascular system to a netted cylinder, imbedded in the general cellular tissue of the stem, and giving off fasciculi both to the petroles and the rootlets. This arrangement is very regular in all the species, but there is great diversity in the course of the dark-coloured or woody tissue. Reference was made to the independent origin of the rootlets, and to the general relations of this form of stem to those of the higher plants. The paper was illustrated by diagrams, and by preparations and dissections of our indigenous ferns, with some comparative specimens of the arborescent species.

GROWTH OF THE DRAGON-TREE.

Professor Piazzi Smyth has communicated to the Botanical Society of Edinburgh, a paper "On the Manner of Growth of Dracæna Draco in its natural habitat, as illustrating some disputed points in vegetable physiology." After alluding to the vertical theory of growth in plants, as maintained by Petit-Thouars and Gaudichaud, and the horizontal theory of Mirbel and Trecul, together with the last pronunciation of opinion thereon by the French Academy, to which his attention had been called by Professor Balfour, the author proceeded to describe such characteristics as he had been able to make out in the Dragon-trees of Teneriffe, growing there indigenously, and through various periods of time, from five to, as it has been alleged, in the case of one specimen, five thousand years; and these characteristics he proved by reference to photographs of the several trees taken by himself at the time of observation. An examination was also instituted between these photographs and the drawings published by various travellers, from Ozonne and Humboldt, at the beginning of the century, down to Dr. Herman Schacht in the present year; and the general conclusion was drawn, that no botanist, even although at the same time a great artist, should think of dispensing in the present day with the aid of photography in bringing home the facts and appearances of vegetable growth in distant lands.

SHEA BUTTER.

MR. BARTER, in a letter to Sir William Hooker, thus describes the economy of this useful product. The nuts of the tree (*Bassio Parkii*) are allowed to ripen on the trees, and being gathered, the pulp surrounding the nut is rubbed off, and generally eaten: it resembles an over-ripe pear. The nut is next dried by exposing it to a slow heat in large clay caldrons with perforated bottoms. This, besides carrying off the moisture, causes the nut to shrink in its shell, of which it is next divested by threshing on the floor; or sometimes it is slightly bruised in large wooden mortars instead. The nut is then thoroughly pounded in pestle and mortar, and next ground between stones: at this stage it resembles black mud in paste. This mass is washed in cold water, then boiled till the butter rises white, and is skimmed from the surface. Shea butter remains hard at a high temperature when well prepared, and does not become rancid with age. It has a slight smoky taste, acquired during its preparation. It is stated to be likely to fetch 5*l.* per ton more than palm-oil.

NEW ARROW-POISON FROM CHINA.

IN a newspaper printed at Shanghae, in the spring of 1857, a wonderful account was given of a poison, which was said to be employed in the interior of China for destroying the largest animals. Instant death was said to be produced when an animal was struck in the trunk of the body with an arrow poisoned with it. Such was its potency, according to the opinion of the Chinese, that a scheme was said to have been set on foot for destroying the British army during the late war, by bringing down to Canton the natives who were in the practice of using it. But the scheme was frustrated by peace being unfortunately proclaimed too soon.

The poison, and apparently the plant also, are known by the Chinese name of *Wu-Tsau*, or Tiger-poison. Dr. Christison received very lately from Dr. Macgowan, an American physician residing at Shanghae, a specimen of the poison, and of the root of the plant from which it is prepared. The root presents all the characters of an *Aconitum* on a very small scale. This corresponds with the conclusion to be drawn from the characters of a few leaves which were also sent, and which scarcely differ from those of *Aconitum ferox*. A farther proof is, that the root produces in an intense degree the very singular combination of numbness and tingling, which is occasioned by chewing the root of any of the active aconites known in Europe, such as *A. Napellus*, *ferox*, *sinense*, *uncinatum*. The poison itself, contained in a little porcelain bottle, is obviously a very well prepared extract: and if not entirely composed of the extract of the wu-tsau root, at all events must contain it largely, for a very minute quantity produces the most intense tingling and numbness of the tongue and lips after it is chewed.

There can be no doubt, therefore, that the wu-tsau poison must be extremely energetic. But the author objected to the admission that either this or any other arrow-poison can produce instant death, as is often stated by travellers. Every poison, however energetic, must be absorbed into the blood before it can act. Even from a wound, absorption cannot take place suddenly. Some time is required before enough can enter the blood. When death takes place instantly, the cause must be mechanical violence inflicted by the arrow. The author exhibited various poison-arrows used in different parts of the world, which were adequate to occasion most deadly wounds if they struck the trunk of the body over an important organ; and he also showed that even the little slender wooden poison-darts, used in some parts of the world for destroying birds and small animals, by being shot from a blowing-tube, may be easily projected with a force amply sufficient to kill a small bird or animal by the violence inflicted, apart from the more tardy deleterious influence exerted by the poison.—*Dr. Christison; Proceedings of the Royal Society of Edinburgh.*

CULTIVATION OF LAVENDER.

MR. S. PERKS, who cultivates at Hitchin, Herts, the plants Lavender, Elaterium, Belladonna, Henbane, and Aconite, has contributed some interesting details of the same to the *Pharmaceutical Journal*.

Lavender is only grown to any considerable extent at Hitchin and Mitcham; the species being the common garden Lavender (*Lavendula vera*, D.C.) At Hitchin there are about 35 acres; and, on an average, about 60 lbs. of good lavender flowers yield about 16 ounces of essential oil, which is commonly worth ten or twelve times as much as that derived from the French spike lavender.

The Hitchin oil of lavender has a remarkably fine, delicate, and sweet odour, being free from all rankness, while it possesses a very rich, strong perfume. Its excellent quality is due to the favourable character of the soil in which it is produced, and the very careful manner in which the plants are raised and cultivated, and to the fact of the flowers alone being used for distillation; or, at all events, mixed with a very small portion of the stalks.

We can bear testimony to the delicacy, sweetness, and strength of Mr. Perks's concentrated Lavender-spirit, which enjoys a wide reputation.

Geology and Mineralogy.

PROGRESSIVE DEVELOPMENT.—ORIGIN OF SPECIES.

THE two following passages are from the inaugural address of Sir Charles Lyell, as President of the Section of Geology, at the late meeting of the British Association :*—

"Among the communications sent in to this Section is one received from Dr. Dawson, of Montreal, confirming the discovery which he and I formerly announced, of a land shell, or pupa, in the coal formation of Nova Scotia. When we contemplate the vast series of formations intervening between the tertiary and carboniferous strata, all destitute of air-breathing mollusca, at least of the terrestrial class, such a discovery affords an important illustration of the extreme defectiveness of our geological records. It has always appeared to me that the advocates of Progressive Development have too much overlooked the imperfection of these records, and that, consequently, a large part of the generalizations in which they have indulged in regard to the first appearance of the different classes of animals, especially of air-breathers, will have to be modified or abandoned. Nevertheless, that the doctrine of progressive development may contain in it the germs of a true theory, I am far from denying."

"Among the problems of high theoretical interest which the recent progress of Geology and Natural History has brought into notice, no one is more prominent, and, at the same time, more obscure, than that relating to the Origin of Species. On this difficult and mysterious subject a work will very shortly appear, by Mr. Charles Darwin, the result of twenty years of observation and experiments in Zoology, Botany, and Geology, by which he has been led to the conclusion, that those powers of nature which give rise to races and permanent varieties in animals and plants, are the same as those which, in much longer periods, produce species, and, in a still longer series of ages, give rise to differences of generic rank. He appears to me to have succeeded, by his investigations and reasonings, to have thrown a flood of light on many classes of phenomena connected with the affinities, geographical distribution, and geological succession of organic beings, for which no other hypothesis has been able, or has even attempted to account." (Mr. Darwin's work has since appeared.)

VEINED STRUCTURE OF GLACIERS.

PROFESSOR TYNDALL, in a paper read by him to the Royal Institution, illustrates his theory of the blue veins as follows :—That the Glacier, when subjected to intense pressure, also liquefies *in flats* perpendicular to the direction of pressure : a means is thus provided for the expulsion of the air entangled in the ice, or, in other words, for the production of veins containing less of air than the general mass of the glacier. A portion of the water will be absorbed by the adjacent bubbled ice, and refrozen when released from the pressure; and the veined structure will follow.

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* Twenty-ninth Anniversary, held at Aberdeen, Sept. 14th ; H.R.H. the Prince Consort, President.

(See the entire paper, illustrated with diagrams, in the *Proceedings of the Royal Institution.*)

WATER SUPPLY.

At the late meeting of the British Association, the President of the Geological Section stated a curious case that had come under his own notice at Portsmouth Victualling Yard. A supply of water was wanted. On the opposite side of the estuary were two artesian wells, at depths of 250 feet and 280, or thereby, respectively. Taking the advice of some persons who were geologists, the superior officer proceeded to lay out the money granted for water supply in digging another artesian well on the Portsmouth side, naturally expecting to find water at about the same depth as on the other side. At 300 feet, however, in the London clay no water appeared; his superior got uneasy, but was persuaded to go on; at 400 feet no water! Again they went on, but only at 560 feet, or thereby, on getting through into the plastic clay, was water obtained, which rose to within three feet of the surface.

GEOLOGY OF VANCOUVER'S ISLAND.

Mr. H. Bauerman, in a communication to the Geological Society, has described the Geology of the south-east part of Vancouver's Island. The author detailed, first, the metamorphic rocks which are everywhere seen in the neighbourhood of Esquimalt and Victoria; principally dark-green sandstones and shales, passing insensibly into serpentine, chlorite-schist, mica-slate, and gneiss. At some places unfossiliferous crystalline limestones are associated with them. Dykes of greenstone, syenite, porphyries, and trap-rocks frequently penetrate the metamorphic rocks. To the westward of Esquimalt black cherty limestones and red porphyry occur.

To the north, at Nanaimo, rocks with cretaceous fossils appear, also at Comoux Island, 21 miles N.W. of Nanaimo. The fossils occur in nodules, and consist of Fish-scales, *Nautilus*, Ammonites, Baculites, *Inoceramus*, *Astarte* (?), *Terebratula*.

Lignitiferous deposits (sandstones, grits, conglomerates, and micaceous flagstones) succeed the cretaceous rocks, and are extensively developed over a great extent of country, forming the mass of the islands in the Gulf of Georgia, as far south as Saturna Island. Northward, they occur at Fort Rupert. Two seams of coal, averaging 6 to 8 feet each in thickness, occur in these beds, and are extensively worked for the supply of the steamers navigating between Victoria and the Frazer River. The coal is a soft black lignite, interspersed with small lenticular bands of bright crystalline coal. Retinite is common in the more earthy portions. Shales with plant-remains are interstratified with the lignite. At Bellingham Bay, on the land, similar coal-bearing sandstones have been observed by the American geologists.

A pleistocene boulder-clay is widely distributed over the southern part of Vancouver's Island and the opposite coasts of the mainland. In the neighbourhood of Esquimalt and Victoria, the rocks are deeply scratched and grooved along the shore; and so also is the rock-surface beneath the drift, which at Esquimalt Harbour is about 20 feet thick, whilst it is much more at the Barracks, and more than 190 feet thick between Albert Head and Esquimalt.

GEOLOGY OF SOUTHERN AUSTRALIA.

MR. A. R. C. SELWYN, Director of the Geological Survey of Victoria, writes to Sir R. I. Murchison, F.G.S., that he has remarked, as to the impoverishment of auriferous veins in depth, the only evidence of such being the case in Victoria is the great richness of the older drifts; for, judging from the large size of the nuggets sometimes found in the gravels, compared with that of the nuggets met with in the gold-bearing quartz-veins (usually from about ¼ dwt. to ½ oz., though occasionally as much as 12 oz., or even 13 lbs.), the upper portions of the veins, now ground down into gravel, were probably richer in gold (as formerly suggested) than the lower parts, now remaining. As far as actual mining experience shows, some of the "quartz-reefs" in Victoria prove as rich in gold at a depth of 200, 230, and 400 feet as at the surface; the yield, however, fluctuates at any depth yet reached. According to the author's latest observations, the gold-drifts, and their accompanying basaltic lavas, are of Pliocene and Post-pliocene age. Miocene beds occur at Corio Bay, Cape Otway coast, Murray basin, and Brighton; and Eocene beds on the east shore of Port Philip, Muddy Creek, and Hamilton. Two silicified fossils (Enchinoderm and Coral), thought by Professor M'Coy to be of Cretaceous origin, have been found in the gravel near Melbourne.

This letter also contains some remarks on the probability of some of the coal of Eastern Victoria being of "Carboniferous" age,—on the occurrence of Silurian fossils in the rocks of all the gold-districts,—on the newly-discovered bone cave at Gisborne, about twenty-five miles north of Melbourne,—and on the progress of the Geological Society of the colony.

AUSTRALIAN GOLD.

PROFESSOR TENNANT has exhibited at the Royal Institution an unusually large and beautiful lump of native Gold brought from the Gingomer Diggings, 120 miles from Melbourne. When melted (August 4, 1858,) it yielded 6905*l.* 12*s.* 9*d.* The amount of gold received from Australia was: in 1855, 125 tons; 1856, 147 tons; and in 1858, 106 tons.

GOLD-FIELD OF BALLARAT.

MR. H. ROSALES, in a communication to the Geological Society, describes the position of the quartz-lobes (the matrix of the gold) in the schists of the hill-ranges, from whence originate the numerous auriferous gullies, forming eventually several channels (charriages), and the different courses of the old gold-bearing streams, which gradually passing to lower levels, reach the great areas of basalt, under which they continue their hidden course. To illustrate these points, the author has prepared and sent a MS. map of the district from beyond Buninyong to Creswick, on which the granite, basalt, schists, and quartz-lodes were shown, as well as the gold-channels, gullies, runs, leads, &c., connected with which ninety-six named spots or diggings were carefully indicated.

THE COAL-FORMATION AT AUCKLAND, NEW ZEALAND.

MR. HENRY WEEKES, in a communication to the Geological Society, says:—This district is formed of stratified sandy clays, of tertiary age; they vary in colour from white to light-red. The white clays contain beds of lignite, varying from a few inches to several feet in thickness. Sections of these beds are exposed along the banks of most of the tidal inlets with which the district abounds. In some places, near the hills, the lignite is seen to rest on trap-rock; elsewhere a shelly gravel underlies it.

At Campbell's farm a whitish sandstone lies on the lignite, and at the junction is hardened, and contains ironstone-nodules: these, when broken, yield remains of exogenous plants. A fossil resin is found abundantly in the lignite. On Farmer's land the lignite is 16 feet thick, including a little shale; at Campbell's it is 7 feet thick, but thins away. There is some iron-pyrites in the lignite, but not sufficient to deteriorate its value as a coal. Similar coal has been found at Muddy Creek to the N.W.; at Mokau, about 100 miles to the south; and near New Plymouth.

The Auckland tertiary beds are everywhere broken through by extinct volcanoes, varying from 200 to 800 feet in height. The craters are generally scoriaceous, in a perfect condition, with a depression of the rim usually to the north or east. There are also around the district other volcanic hills, rounded, scoriaceous, more fertile than the crateriform hills, and apparently of an older date.

COAL IN SOUTH AFRICA.

MR. R. THORNTON has communicated to the Geological Society a paper "On the Coal found by Dr. Livingstone at Tete, on the Zambesi, South Africa." Mr. Thornton states that this coal is free-burning; showing no tendency to cake; containing very little of either sulphur or iron, a large proportion of ash, but only a little gaseous matter. The result of the trial (made in the steam-launch) of this coal, and its appearances, favour, in the author's opinion, the idea that the coal, when taken from a deeper digging (that which Dr. Livingstone had sent was collected at the surface of the ground), will probably contain less ash and a little more gaseous matter.

OSSIFEROUS CAVERNS AND FISSURES OF

MR. PENGELLY, F.G.S., has read to the Royal Institution a paper, in which, after noticing the caverns which abound in the limestone districts of Devonshire, he proceeds to detail the recently-discovered cavern on Windmill Hill, Brixham, found by some workmen, in digging for the foundation of a building, in January, 1858: they came upon a hole, at first only the size of a man's hand, but which soon became large enough to permit Mr. Philp, proprietor of the ground, to enter. He proceeded as far as fifty feet, and brought out bones, of which he forthwith made an exhibition, and thereby attracted the attention of local geologists. The cavern was speedily visited by Sir R. I. Murchison, Drs. Falconer and Percy, Professor Ramsay, Mr. Prestwich, and other eminent geologists. The Royal Society granted 100*l.* as a contribution towards the expense of a scientific exploration of the cavern; additional sums were quickly subscribed; and a committee was formed to arrange and direct the course of proceeding.

Mr. Pengelly described the structure and formation of the cavern, and the mode of exploration adopted; and stated that there had been discovered in it a very considerable number of bones of animals, extinct and recent (the rhinoceros, ox-tribe, horse, cave-bear, hyæna, &c.), and also several well-marked specimens of the objects commonly known as "flint knives," and which are generally considered to be of human manufacture. Similar articles had also been found in Kent's Cavern, in a corresponding situation, namely, in the "bone-earth," with the bones of extinct and recent animals, beneath the floor of stalagmite. Many fossils from the Oreston fissures were placed on the lecture-table; and on the wall were suspended diagrams of the ground plan of the Brixham cavern, &c.

Mr. Pengelly briefly explained his views on the probable origin of caverns in general, and of the Brixham cave in particular: which he referred to,—1st, The production of a line of fractures; 2nd, The chemical action of acidulated water, through such fractures; 3rd, The mechanical action of running water charged with rock débris, &c.

With respect to the chronology of the cavern and its contents, the speaker referred to the remains of the great herbivora, as evidences of the place having had a tropical or sub-tropical climate at the time of these deposits, and considered that whatever was the antiquity of the bone-earth in the cavern, the human period is as ancient. He thought that many facts concur to suggest a re-investigation of the antiquity of the human race; and he also considered it highly desirable to organize a system for the general exploration of caverns.

In the course of the lecture, Mr. Pengelly alluded to the various papers which had been published on the Devonshire caverns, viz.: Mr. Whidbey's Description of the Fissures at Oreston, near Plymouth, in the *Philosophical Transactions* for 1817. A paper on the Yealmpton Caverns, by Lieutenant-Colonel Mudge, read before the Geological Society of London, March 23, 1836; Mr. Austen's paper on the Bone Caverns of Devonshire, read before the Geological Society, March 25, 1840; and the Rev. Mr. McEnery's *Cavern Researches*, being principally a memoir of Kent's Cavern, which was long supposed to be lost, but recently discovered and published by Mr. Vivian, of Torquay.

(For Mr. Pengelly's previous account of the Brixham Cavern, with Professor Owen's remarks upon the discovery, see *Year-Book of Facts*, 1859, p. 266.)

Mr. Prestwich has also briefly described the Brixham Cave, as having been traced along three large galleries, meeting or intersecting one another at right angles. Numerous bones of *Rhinoceros tichorhinus*, *Bos*, *Equus*, *Cervus tarandus*, *Ursus spelæus*, and

Hyæna have been found: and several flint instruments have been met with in the cave-earth and gravel beneath. One, in particular, was found beneath a fine antler of a Reindeer and a bone of the Cave-bear, which were imbedded in the superficial stalagmite in the middle of the cave.

CANADIAN CAVERNS.

DR. G. GIBB has communicated to the British Association a paper in which he described thirty distinct series of cavernous localities existing throughout the province of Canada. These were divided into two classes, the first comprising caverns which are at the present time washed by the waters of lakes, seas, and rivers, including arched, perforated, flower-pot, and pillared rocks, which have at one time formed the boundaries or walls of caverns, and all of them the result of aqueous action. The second comprised caverns and subterranean passages which are situated on dry land, and not attributable to the same cause in their origin. Amongst the more remarkable which were noticed were the arched rocks at Percé, Gaspe; the flower-pot rocks of the Mingan Islands; the basaltic caverns of Henley Island, which the author represented as miniature Fingal's Caves; empty basaltic dykes of Great Mecattina Island—these are of great magnitude, and probably the most remarkable things of the kind as yet known; Bouchette's Cavern in the county of Kildare, consisting of five or more caverns or galleries, running one hundred and ninety-five feet in the limestone rock; the Mono and Eramosa caverns, represented as belonging to a great series, some of them of huge dimensions, existing in the Niagara limestone rocks, running from the western end of Lake Ontario northwards to the Georgian Bay; the subterranean passages of the great Manitoulin Island, Lake Huron; and Murray's cavern and subterranean river, on the Bonne-chère, Ottawa. In none have animal remains been found so far, unless in one instance, in Colquhoun's Cavern, Lanark; and they were presumed to belong to a species of large deer, but were transmitted to the late Dr. Buckland for examination thirty years ago. Not a single object, such as a flint arrow-head, or spear, used by the ancient inhabitants of the country, was observed in any of them. Several plans, drawings, and sketches accompanied the author's paper; the geological position of every cavern was correctly laid down, and nearly all were found to occur in limestone rocks.

PROFESSOR OWEN ON FOSSIL MAMMALS.

PROFESSOR OWEN has delivered at the Royal Institution a most interesting series of lectures "On Fossil Mammals," which he thus impressively concluded:—

"Turning from a retrospect into past time to the prospect of time to come,—and I have received more than one inquiry into the amount of prophetic insight imparted by Palæontology—I may crave indulgence for a few words, of more sound, perhaps, than significance. But the reflective mind cannot evade or resist the tendency to speculate on the future course and ultimate fate of vital phenomena in this planet. There seems to have been a time when life was not;

there may, therefore, be a period when it will cease to be. Our most soaring speculations still show a kinship to our nature; we see the element of finality in so much that we have cognizance of, that it must needs mingle with our thoughts, and bias our conclusions on many things. The end of the world has been presented to man's mind under divers aspects:—as a general conflagration; as the same, preceded by a millennial exaltation of the world to a Paradisiacal state,—the abode of a higher and blessed race of intelligences. If the guide-post of Palæontology may seem to point to a course ascending to the condition of the latter speculation, it points but a very short way, and in leaving it we find ourselves in a wilderness of conjecture, where to try to advance is to find ourselves 'in wandering mazes lost.'

"With much more satisfaction do I return to the legitimate deductions from the phenomena we have had under review.

"In the survey which I have taken in the present course of lectures of the genesis, succession, geographical distribution, affinities, and osteology of the mammalian class, if I have succeeded in demonstrating the perfect adaptation of each varying form to the exigencies, and habits, and well-being of the species, I have fulfilled one object which I had in view, viz., to set forth the beneficence and intelligence of the Creative Power. If I have been able to demonstrate a uniform plan pervading the osteological structure of so many diversified animated beings, I must have enforced, were that necessary, as strong a conviction of the unity of the Creative Cause. If, in all the striking changes of form and proportion which have passed under review, we could discern only the results of minor modifications of the same few osseous elements,—surely we must be the more strikingly impressed with the wisdom and power of that Cause which could produce so much variety, and at the same time such perfect adaptations and endowments, out of means so simple. For, in what have those mechanical instruments,—the hands of the ape, the hoofs of the horse, the fins of the whale, the trowels of the mole, the wings of the bat,—so variously formed to obey the behests of volition in denizens of different elements—in what, I say, have they differed from the artificial instruments which we ourselves plan with foresight and calculation for analogous uses, save in their greater complexity, in their perfection, and in the unity and simplicity of the elements which are modified to constitute these several locomotive organs? Everywhere in organic nature we see the means not only subservient to an end, but that end accomplished by the simplest means. Hence we are compelled to regard the Great Cause of all, not like certain philosophic ancients, as a uniform and quiescent mind, as an all-pervading *anima mundi*, but as an active and anticipating intelligence. By applying the laws of comparative anatomy to the relics of extinct races of animals contained in and characterizing the different strata of the earth's crust, and corresponding with as many epochs in the earth's history, we make an important step in advance of all preceding philosophies, and are able to demonstrate that the same pervading, active, and beneficent intelligence which manifests His power in our times, has also manifested His power in times long anterior to the records of our existence. But we likewise, by these investigations, gain a still more important truth, viz., that the phenomena of the world do not succeed each other with the mechanical sameness attributed to them in the cycles of the Epicurean philosophy; for we are able to demonstrate that the different epochs of the history of the earth were attended with corresponding changes of organic structure; and that, in all these instances of change, the organs, as far as we could comprehend their use, were exactly those best suited to the functions of the being. Hence we not only show intelligence evoking means adapted to the end; but, at successive times and periods, producing a change of mechanism adapted to a change in external conditions. Thus the highest generalizations in the science of organic bodies, like the Newtonian laws of universal matter, lead to the unequivocal conviction of a great First Cause, which is certainly not mechanical. Unfettered by narrow restrictions,—unchecked by the timid and unworthy fears of mistrustful minds, clinging, in regard to mere physical questions, to beliefs, for which the Author of all truth has been pleased to substitute knowledge,—our science becomes connected with the loftiest of moral speculations; and I know of no topic more fitting to the sentiments with which I desire to conclude the present course. If I believed,—to use the language of a gifted contemporary,—that the imagination, the feelings, the active intellectual powers, bearing on the business of life, and the highest capacities of our nature, were blunted and impaired by the study of physiological and palæontological phenomena, I should then regard our science as little better than a mere sepulchre, in which, like the strong man, we were burying ourselves and those around us in ruins of our own creating. But surely we must all believe too firmly in the immutable attributes of that Being, in whom all truth, of whatever kind, finds its proper resting-place, to think that the principles of physical and moral truth can ever be in lasting collision."

"FOSSIL LIGHTNING."

DR. G. GIBB has communicated to the *Geological Journal* a paper on "Fossil Lightning," better known as *Fulgurites*—a term used by mineralogists to designate a condition resulting from the lightning's flash ages gone by. Professor Owen uses the expression in his lectures on fossil birds, when speaking of the various modes in which the evidence of evanescent things become recognisably preserved in rock, as illustrated by meteoric phenomena, footprints, soft and soluble plants, and animals. Dr. Gibb has discovered examples of such bodies on the surface of the flagstones which form our pavements, in specimens of rock from Canada, and in various other places.

REPTILIAN REMAINS.

A PAPER has been read to the British Association "On the newly-discovered Reptilian Remains from the neighbourhood of Elgin," by Professor Huxley. Having received specimens of sandstone containing what he considered traces of reptilia, in order to work out the problem of their character, he was put in communication with Mr. Duff and the Rev. Mr. Gordon, but for whose efficient co-operation his labours must have been in vain. He was fortunate to obtain specimens containing impressions which led him to conclude it was a reptile, and not a fish. He next obtained impressions in the sandstone of what appeared to have been once a bone, resembling the bony plates of an alligator, from which he came to the conclusion that the reptile was one of the crocodilian species. Looking for further coincidence, he had received a fossil, which Professor Agassiz had declared the most extraordinary he had ever seen; and a cast taken from it appeared to represent the tail of the old reptile. He then had a cast taken from a fossil having a most extraordinary cavity in it, which appeared to be its dorsal vertebræ; from another specimen he got a piece of vertebra, such as support the hips in crocodiles; and he, too, got a bit of sandstone having an impression of vertebræ, with marks peculiarly characteristic of the neck; and to ascertain what the teeth or head was like, they had obtained a piece of stone with the impression of an upper jaw and a series of teeth, essentially resembling those of a crocodile, and from these and other traces he came to the conclusion that it had been a crocodilian reptile allied to the Dinosaurian series, but presenting various points of difference from all existing or fossil species, and that the period of its existence must have been that presented by the green sandstone. He also gave an account of the impressions in other pieces of sandstone—which Mr. Gordon had sent him—indicating another reptile, with curious palatal teeth, which in honour of the Rev. Mr. Gordon, he called *Hy-*

perodapedon Gordoni. He also received two bits of rock, one containing a reptilian impression like a stagonolepis.

Professor Owen said no one could fail to be impressed with the extreme minuteness and accuracy with which Professor Huxley had examined the facts, and with the clearness with which the facts had been described; and still more with the accuracy and soundness of the deductions which Professor Huxley had made. The paper read afforded very instructive evidence of the value of the law of correlation of structure; because, at the last meeting of the British Association at Leeds, he had arrived at the conclusion, from observing a portion of the bone then exhibited, that these specimens were reptilian in their nature, and had published that opinion in an article in the *Encyclopædia Britannica*. He concurred entirely with the conclusions which Professor Huxley had drawn from a more complete view of those bones. He now for the first time began to feel that the evidence of the structure of the cranium was most interesting, and necessary to be made known before they had a complete and satisfactory idea of the nature of the stagonolepis.

REPTILIAN EGGS.

PROFESSOR BUCKMAN has read to the Geological Society, a paper "On a Group of supposed Reptilian Eggs (*Oolithes Bathonicæ*) from the Great Oolite of Cirencester." The specimen referred to was obtained by Mr. Dalton from the Harebushes quarry near Cirencester, and presents evidence of a compact cluster of eight oval bodies (each about two inches long and one inch across) in a mass of oolitic rock. These oval bodies being equally rounded at the ends, and in this differing from birds' eggs, the author thinks that they must have been the eggs of a reptile. The egg-shells were very thin, have been here and there puckered by pressure, and are more or less occupied with calc-spar.

DURA DEN AND ITS FOSSIL FISHES.

THE REV. DR. ANDERSON has read to the Geological Society, a paper "On the Yellow Sandstone of Dura Den and its Fossil Fishes." The author described the sedimentary strata in the vicinity as consisting of (in ascending order) 1. Grey sandstone, the equivalent of the Carmylie and Forfarshire flagstones, with *Cephalaspis* and *Pterygotus*. 2. The red and mottled beds, such as those of the Carse of Gowrie, and the Clashbennie zone with *Holoptychius nobilissimus*, *Phyllolepis concentricus*, and *Glyptolepis elegans*. 3. Conglomerates, marls, and cornstone, with few and obscure fossils. 4. The Yellow Sandstone, rich in remains of *Holoptychius* and other fishes, and about 300 or 400 feet in thickness. This sandstone is seen to rest unconformably on the middle or Clashbennie series of the Old Red at the northern opening of the Den, and at the southern end is unconformably overlaid by the carboniferous rocks. It is also exposed beneath the lower coal-series of Cults, the Lomonds, Binnarty, and the Cleish Hills. It is seen also in Western Scotland (Renfrewshire and Ayrshire), and also in Berwickshire and elsewhere in the south, with its Pterichthyan and Holoptychian fossils. In the author's opinion it is entirely distinct from the "Yellow Sandstone" of the Irish geologists.

At Dura Den the yellow sandstone in some spots teems with fossil fish, especially in one thin bed. In 1858 a remarkably fine *Holoptychius Andersoni* was met with; and this, with many other specimens, fully bears out Agassiz's conjectures for completing the form and details of the fish where his materials had been insufficient.

ELEPHANT REMAINS AT ILFORD.

Mr. A. Brady has communicated to the British Association, a paper on this discovery. The first fossil (says Mr. Brady) to which I wish to direct attention is the tusk of an enormous Mammoth, which was discovered about two years since. It was lying on its side, about 14 feet below the present surface of the soil; and I had the honour of inviting Sir Charles Lyell, and other eminent geologists, to see it before it was disturbed. It belonged to an animal of the species *Elephas primogeneus*, and is identical with the Siberian mammoth, and, I believe, with the one found in Behring's Straits. The tusk was decayed at each end, the extremities being gone, but the part preserved was over 9 feet long, and of proportionate bulk. Some idea may be formed from this of the huge size of the animal of which it formerly formed a part. It was very much incurved, being so much bent back that the bone was not more than 4 feet 2 or 3 inches across in any part. Owing to the nature of the soil, the whole tusk was very friable, most of the gluten of the ivory being decayed, so that great care was required in moving it to prevent it falling to pieces. This was done in the usual manner by the authority of the British Museum, to whom, by permission of Mr. Curtis, I presented the fossil: it was, however, I regret to say, much damaged by removal, notwithstanding the care bestowed. It was nearly a year afterwards before any more bones were found. I then obtained a large tibia, and two molar teeth, probably belonging to the same animal, as they were not a great way from the tusk. One of the latter was very large, weighing about 12 lb., though, from long use, much worn. From this I infer that the mammoth to which it belonged must have been of great age. About the same time, I obtained several bones of a large rhinoceros. These, from their more compact nature, were less decayed; and the tibia and one side of the jaw were very perfect, several teeth being *in situ*. The other half of the jaw was smashed by the workman's pick before I saw it; but I saved several teeth. Like those of the mammoth, they were very much worn. Two of them I gave to the College of Surgeons. The rhinoceros has been referred to the genus Leptorhinus. Associated with these remains were some of the bones of a large ox, the horns and skull of which were very perfect, with several teeth *in situ*. There were also turned up, within the last month or two, some bones of a large ruminant, which I believe to be of the Minocero, or Irish elk; but I have not yet been able to get them exhibited. About thirty years since, the late Dr. Buckland discovered the bones of a mammoth in this locality; and about the same time the late Mr. Gibson obtained the beautiful collection of bones now in the Royal College of Surgeons. Associated with the remains of those giants of ancient days are the skulls of Planorbis, Mico, Cyclon, Paludina, &c. And there are now living in the Roden, and other tributary brooks in the neighbourhood, the *lineal* descendants of these fossils, the ancestors of which enjoyed the same sunshine as the mammoth and rhinoceros, the aristocracy of those days. We boast not of the primary rocks of Scotland, but we have amongst us, living on the same estate as their ancestors, the humble Paludina, Planorbis, &c. They are interesting, for they form, as it were, the link between the past and the present order of things.

Sir Charles Lyell expressed his opinion of the very interesting nature of this paper, showing, as it did, how near to the existence of man on earth those huge creatures lived; the vegetation of their time being such as we are acquainted with. He did not by any means suggest that they were contemporaneous with man, and they must disabuse their minds of the opinion that anything said or published by the geologists was calculated to destroy any rational belief. They did not and could not assert—because they had no evidence—that man lived 15,000 or 20,000 years ago; but they produced evidence to show that those creatures lived nearer to our own time than had been supposed; whether at the exact chronology of 6000 years, or thereby, is a matter of indifference.

PRESERVATION OF FOOTPRINTS ON THE SEA-SHORE.

MR. ALEXANDER BRYSON, in a paper communicated to the Royal Society, remarks that the impressions of the feet of birds and molluscs on wet sand were liable to be effaced by the return of the tide; and that their preservation was owing to dry sand blown into the depressions from the shore, and again covered by a layer of moist sand or mud by the return of the tide. In regard to tracks left by gasteropodous molluscs, he stated that great caution was necessary to distinguish them from those left by Nereids; and instanced the case of a foot-track of a common whelk resembling the marks made by the Crossopodia on the Silurian slates. When the track of the whelk is filled up by the dry sand blown into the depression in the *line* of progress, no difficulty is felt in recognising it as the track of a gasteropod; but should the wind blow at right angles to the track of the mollusc, a series of setæ-like markings will be observed to leeward, caused by the dry sand adhering to the moist. In this instance, a geologist would naturally assign the markings to the impression of *Graptolites priodon*, or *sagittatus*; and if the wind suddenly shifted to the opposite direction, another series of setæ would be found on the other side of the mollusc's track, and the observer would at once pronounce the marks due to a gigantic Crossopodia, or fringe-footed Annelide.

The author also stated, that the so-called rain-marks found on sandstone and Silurian slates were formed by Crustacea, and that the cusps which geologists had supposed were the evidence of the force and direction of the wind during the shower, were produced by the wind blowing dry sand from the shore, and causing a raised barrier to leeward of the depression, where there was more moisture, and consequently more adhesion of the sand.—*Edinburgh New Philos. Journal*, No. 20.

SUPPOSED ANTIQUITY OF THE HUMAN RACE.—FLINT IMPLEMENTS IN THE DRIFT.

IN the *Year-book of Facts*, 1859, page 256, we detailed the researches of Mr. Leonard Horner in the sedimentary deposits of the Nile in Egypt, which Baron Bunsen has adopted as a grand proof that man has existed on this earth for 20,000 years! To expose this sceptical fallacy, it will be necessary to repeat a portion of Mr. Horner's inferences. His excavations were made at the base of the statue of Rameses II., at Mehahenny, on the site of ancient Memphis. He found an accumulation of 9 feet 4 inches of Nile mud upon it, and assuming "the middle of the reign of this Pharaoh to be about 1360 B.C., and adding to this 1854 (the date of Mr. H.'s excavation), we have 3215 years for the accumulation of 9 feet 4 inches of sediment, and the mean rate of increase will be 3½ inches per century or thereabouts." From thence Mr. Horner proceeded downwards with a borer, and "at a depth of 39 feet from the surface of the ground, the borer brought up a fragment of pottery." He triumphantly adds, "this bit of pot must be held to be a record of the existence of man upon earth 13,371 years before 1854, if there be no fallacy in my reckoning." Unfortunately for Mr. Horner there *is* a fallacy in his reckoning, and a very obvious one; and moreover, one which no man living would have had a sharper eye to detect than the Baron Bunsen, had the result been against his theory instead of in its favour. The statue at Mehahenny was originally one of four caryatides supporting the entrance front to the temple Phtha, which, like all other Egyptian temples, was built on a mound sufficiently elevated to prevent its ever being overflowed by the annual rise of the Nile. This mound must have subsided in the earthquake which overthrew the statue. When this took place we have no certain record: earthquakes are by no means uncommon in Egypt. We know, however, for certain that this statue was upright and uninjured only six centuries ago, for it is expressly and unmistakeably described amongst the wonders of Memphis by the Arab historian Abdallatiff, who visited its ruins at that time, and has left us an account of them. Mr. Horner's 9 feet 4 inches of sediment has therefore unquestionably accumulated in less than six centuries instead of more than thirty. This egregious blunder is the *pied* upon which Mr. Horner makes his subsequent calculations, and these constitute the main prop and pillar of the Baron Bunsen's assertion that man has been upon the earth for 20,000 years.—(From a letter by Mr. William Osburn, author of the *Monumental History of Egypt*, in the *Literary Gazette*.)

Mr. Sharpe has also pointed out what he considers a fallacy in Mr. Horner's reckoning: he argues that the surface of the ground has risen at the mean rate of three inches and a half in a century—not taking into account the probability, amounting almost to a certainty, that during the first two thousand years, while the city was standing, the embankments would have prevented any mud whatever from being deposited there. Mr. Sharpe argues from Mr. Horner's facts that the rise of the soil at that spot had more probably been four times as rapid as Mr. Horner supposed—that it had all taken place during the last eight hundred years—and that no inundation whatever, and consequently no deposit, had been allowed to reach the foot of the statue till Memphis had ceased to be an inhabited city one or two centuries after the building of Cairo.

Before us are eighteen letters upon this very interesting inquiry, which have been addressed to the public journals; and papers which have been read to the Society of Antiquaries, the Royal Society, the Geological Society, &c. As these communications are in some cases lengthy, and in others mixed up with controversial proof and denial, refutation and disclaimer, they would occupy much more space than our *Year-book* allows; and we prefer to quote the following lucid summary of the subject by Sir Charles Lyell.

No subject (says Sir Charles) has lately excited more curiosity and general interest among geologists and the public than the question of the antiquity of the human race; whether or no we have sufficient evidence to prove the former co-existence of Man with certain extinct mammalia, in caves or in the superficial deposits commonly called drift or "diluvium." For the last quarter of a century, the occasional occurrence, in various parts of Europe, of the bones of man or the works of his hands, in cave-breccias and stalactites associated with the remains of the extinct hyæna, bear, elephant, or rhinoceros, have given rise to a suspicion that the date of man must be carried further back than we had heretofore imagined. On the other hand, extreme reluctance was naturally felt on the part of scientific reasoners to admit the validity of such evidence, seeing that so many caves have been inhabited by a succession of tenants, and have been selected by man as a place not only of domicile, but of sepulture, while some caves have also served as the channels through which the waters of flooded rivers have flowed, so that the remains of living beings which have peopled the district at more than one era, may have subsequently been mingled in such caverns and confounded together in one and the same deposit.

The facts, however, recently brought to light during the systematic investigation, as reported on by Falconer, of the Brixham Cave, must, I think, have prepared you to admit that scepticism in regard to the cave-evidence in favour of the antiquity of man had previously been pushed to an extreme. To escape from what I now consider was a legitimate deduction from the facts already accumulated, we were obliged to resort to hypotheses requiring great changes in the relative levels and drainage of valleys, and, in short, the whole physical geography of the respective regions where the caves are situated—changes that would alone imply a remote antiquity for the human fossil remains, and make it probable that man was old enough to have co-existed, at least, with the Siberian mammoth. But, in the course of the last fifteen years, another class of proofs has been advanced in France in confirmation of man's antiquity, into two of which I have personally examined in the course of the present summer, and to which I shall now briefly advert. First, so long ago as the year 1844, M. Aymard, an eminent palæontologist and antiquary, published an account of the discovery in the volcanic district of Central France, of portions of two human skeletons (the skulls, teeth, and bones), imbedded in a volcanic breccia, found in the mountain of Denise, in the environs of Le Puy en Velay, a breccia anterior in date to one, at least, of the latest eruptions of that volcanic mountain. On the opposite side of the same hill, the remains of a large number of mammalia, most of them of extinct species, have been detected in tufaceous strata, believed, and I think correctly, to be of the same age. The authenticity of the human fossils was from the first disputed by several geologists, but admitted by the majority of those who visited Le Puy, and saw, with their own eyes, the original specimen now in the museum of that town. Among others, M. Pictet, so well known to you by his excellent work on Palæontology, declared, after his visit to the spot, his adhesion to the opinions previously expressed by Aymard. My friend, Mr. Scrope, in the second edition of his *Volcanoes of Central France*, lately published, also adopted the same conclusion; although, after accompanying me this year to Le Puy, he has seen reason to modify his views.

The result of our joint examination—which I believe essentially coincides with that arrived at by MM. Hébert and Lartet, names well known to science, who have also this year gone into this inquiry on the spot, may thus be stated. We are by no means prepared to maintain that the specimen in the museum at Le Puy (which unfortunately was never seen *in situ* by any scientific observer) is a fabrication. On the contrary, we incline to believe that the human fossils in this and some other specimens from the same hill, were really imbedded by natural causes in their present matrix. But the rock in which they are entombed consists of two parts, one of which is a compact, and for the most part thinly laminated stone, into which none of the human bones penetrate; the other containing the bones is a lighter and much more porous stone, without lamination, to which we could find nothing similar in the mountain of Denise, although both M. Hébert and I made several excavations on the alleged site of the fossils. M. Hébert therefore suggested to me that this more porous stone, which resembles in colour and mineral composition, though not in structure, parts of the genuine old breccia of Denise, may be made up of the older rock broken up and afterwards re-deposited, or as the French say, *remané*, and therefore of much newer date, an hypothesis which well deserves consideration; but I feel that we are at present so ignorant of the precise circumstances and position under which these celebrated human fossils were found, that I ought not to waste time in speculating on their probable mode of interment; but simply state that, in my opinion, they afford no demonstration of man having witnessed the last volcanic eruptions of Central France. The skulls, according to the judgment of the most competent osteologists who have yet seen them, do not seem to depart in a marked manner from the modern European, or Caucasian type, and the human bones are in a fresher state than those of the *Elephas meridionalis* and other quadrupeds found in any breccia of Denise which can be referred to the period even of the latest volcanic eruptions.

But, while I have thus failed to obtain satisfactory evidence in favour of the remote origin assigned to the human fossils of Le Puy, I am fully prepared to corroborate the conclusions which have been recently laid before the Royal Society by Mr. Prestwich, in regard to the age of the flint implements associated in undisturbed gravel, in the north of France, with the bones of elephants, at Abbeville and Amiens. These were first noticed at Abbeville, and their true geological position assigned to them by M. Boucher de Perthes, in 1849, in his *Antiquités Celtiques*, while those of Amiens were afterwards described in 1855, by the late Dr. Rigollot. For a clear statement of the facts, I may refer you to the abstract of Mr. Prestwich's Memoir, in the proceedings of the Royal Society for 1859, and have only to add that I have myself obtained abundance of Flint Implements (some of which are laid upon the table) during a short visit to Amiens and Abbeville. Two of the worked flints of Amiens were discovered in the gravel-pits of St. Acheul—one at the depth of 10 and the other of 17 feet below the surface, at the time of my visit; and M. Georges Pouchet, of Rouen, author of a work on the Races of Man, who has since visited the spot, has extracted with his own hands one of these implements, as Messrs. Prestwich and Flower had done before him. The stratified gravel resting immediately on the chalk in which these rudely-fashioned instruments are buried, belongs to the post-pliocene period, all the freshwater and land shells which accompany them being of existing species. The great number of the fossil instruments which have been likened to hatchets, spear-heads, and wedges, is truly wonderful. More than a thousand of them have already been met with in the last ten years, in the valley of the Somme, in an area 15 miles in length. I infer that a tribe of savages, to whom the use of iron was unknown, made a long sojourn in this region; and I am reminded of a large Indian mound, which I saw in St. Simond's Island, in Georgia—a mound ten acres in area, and having an average height of five feet, chiefly composed of cast-away oyster-shells, throughout which arrow-heads, stone-axes, and Indian pottery are dispersed. If the neighbouring river, the Alatamaha, or the sea which is at hand, should invade, sweep away, and stratify the contents of this mound, it might produce a very analogous accumulation of human implements, unmixed, perhaps, with human bones. Although the accompanying shells are of living species, I believe the antiquity of the Abbeville and

Amiens flint instruments to be great indeed, if compared to the times of history or tradition. I consider the gravel to be of fluviatile origin; but I could detect nothing in the structure of its several parts indicating cataclysmal action—nothing that might not be due to such river-floods as we have witnessed in Scotland during the last half-century. It must have required a long period for the wearing down of the chalk which supplied the broken flints for the formation of so much gravel at various heights, sometimes 100 feet above the present level of the Somme, for the deposition of fine sediment, including entire shells, both terrestrial and aquatic, and also for the denudation which the entire mass of stratified drift has undergone, portions having been swept away, so that what remains of it often terminates abruptly in old river cliffs, besides being covered by a newer unstratified drift. To explain these changes, I should infer considerable oscillations in the level of the land in that part of France—slow movements of upheaval and subsidence, deranging but not wholly displacing the course of the ancient rivers. Lastly, the disappearance of the elephant, rhinoceros, and other genera of quadrupeds now foreign to Europe, implies, in like manner, a vast lapse of ages, separating the era in which the fossil implements were framed and that of the invasion of Gaul by the Romans.

It may, however be interesting and useful to those who wish to follow the controversy, first to enumerate the papers just referred to, and glance at their salient points:—

1. Mr. Prestwich's paper read to the Royal Society, May 26th, and reported in the "Proceedings." The author confines himself to the corroboration of the facts:—

That the flint-implements are the work of man.

That they were found in undisturbed ground.

That they are associated with the remains of extinct Mammalia.

That the period was a late geological one, and anterior to the surface assuming its present outline, so far as some of its minor features are concerned.

He does not, however, consider that the facts, as they at present stand, of necessity carry back Man in past time more than they bring forward the great extinct Mammals towards our own time, the evidence having reference only to relative, and not to absolute time; and he is of opinion that many of the later geological changes may have been sudden or of shorter duration than generally considered. In fact, from the evidence here exhibited, and from all that he knows regarding drift phenomena generally, the author sees no reason against the conclusion that this period of Man and the extinct Mammals—supposing their contemporaneity to be proved—was brought to a sudden end by a temporary inundation of the land; on the contrary, he sees much to support such a view on purely geological considerations.

2. A Letter from Mr. John Evans, F.S.A. and F.G.S., regarding these implements from an antiquarian rather than a geological point of view, and dividing them into three classes:—

Flint flakes—arrow-heads or knives.

Pointed weapons truncated at one end, and probably lance or spear heads.

Oval or almond-shaped implements with a cutting edge all round, possibly used as sling-stones or as axes.

Mr. Evans points out that in form and workmanship those of the two last classes differed essentially from the implements of the so-called Celtic period, which are usually more or less ground and polished, and cut at the wide and not the narrow end; and that, had they been found under any circumstances, they must have been regarded as the work of some other race than the Celts or known aboriginal tribes. He fully concurs with Mr. Prestwich, that the beds of drift in which they were found were entirely undisturbed.

3. "Observations on the Discovery in various Localities of the Remains of Human Art mixed with the Bones of Extinct Races of Animals," read to the Royal Society by Mr. Charles Babbage, M.A.

Mr. Babbage's explanations chiefly relate to the caves in Sicily visited by Dr. Falconer, and are illustrated with diagrams. Mr. Babbage, in conclusion, observes that the remains of human art being found imbedded with bones of extinct races of animals in deposits of ancient gravel, admitting the existence of those animals to have been contemporaneous with the original distribution of the gravel, it by no means certainly follows that the race of man was coeval with them. For the remains of man and his rude arts might occur on the surface of that gravel long ages after the extinction of those races of animals. Several causes might produce their mixture;—*a.* A vast lake bursting its barriers by erosion, or by an earthquake, might carry before it in its impetuous course the superficial remains of man, mixed up with gravel containing the bones of the extinct races of animals, and deposit them over a large area of land at a lower level. *b.* The change of the course of a river, or of a branch of its delta, might produce the same mixture of the remains of two distinct and far distant ages. It might, by the clearing out of its new channel, carry off the gravel and the remains of extinct animals, and deposit them, mixed up with specimens of human art, on spots which, after a few centuries, might again reappear as dry land. *c.* A narrow pass, the outlet of a stream of water, might be stopped up by the avalanches falling from a glacier after a severe winter; and the lake formed by the stream might thus periodically rise, until the pressure broke through the barrier. *d.* Amongst the phenomena occurring during earthquakes, it has been observed that large cracks have suddenly opened and as suddenly closed, either immediately or shortly after. During these momentary or temporary openings, the remains of the arts of man, and even man himself, may have dropped into the chasm. Under such circumstances, remains of man and his arts might occur in formations of any date.

Mr. Babbage is satisfied that the flint-instruments have been worked by human hands, from his examination, many years ago, of the mode of making gun-flints. Mr. Babbage attaches much importance to Dr. Falconer finding most of the bones belonging to the hippopotamus, and those in enormous numbers, upon which he founds two conjectures, one dependent on the subsidence of the land, the other upon the rising of the waters. Mr. Babbage says:—The conclusion to which these remarks lead, is that whilst we ought to be quite prepared to examine any evidence which tends to prove the great antiquity of our race, yet that if the facts adduced can be explained and accounted for by the operation of a few simple and natural causes, it is unphilosophical to infer the co-existence of man with those races of extinct animals.

4. The paper by Mr. Evans, of Nash Mills, read to the Society of Antiquaries on June 2nd, detailing facts which prove, almost beyond controversy, the simultaneous deposition of instruments worked by the hand of man, with bones of the extinct mammalia in the drift of the Postpliocene period. Whether the age of man's existence upon the earth is to be carried back far beyond even Egyptian or Chinese chronology, or that of the extinct elephant, rhinoceros, and other animals brought down nearer to the present time than has commonly been allowed, must remain a matter for conjecture. Thus much appears nearly indisputable:—That at a remote period, possibly before the separation of England from the Continent, this portion of the globe was densely peopled by man; that implements, the work of his hands, were caught up together with the bones of the extinct mammalia, by the rush of water through whose agency the gravel beds were formed; that above this gravel, in comparatively tranquil fresh water, thick beds of sand and loam were deposited, full of the delicate shells of fresh-water mollusca; and that where all this took place, now forms table-land on the summit of hills nearly 200 feet above the level of the sea, in a country whose land is now stationary, and the face of which has remained unaltered during the whole period which history or tradition embraces. In conclusion, Mr. Evans suggested a careful examination of all beds of drift in which elephant remains had been found, with a view of ascertaining the co-existence with them of these flint-implements, and still further illustrating their history.

5. A Letter in the *Athenæum*, No. 1651, from Mr. Thomas Wright, the eminent antiquary, who considers the great number of these implements found together

as against the conclusions of Mr. Prestwich and Mr. Evans; nor does Mr. Wright believe these so-called flint implements to be the work of men's hands: they do not at all resemble the flint implements ascribed to the Celtic period, and their forms might have been produced naturally by a violent and continued gyratory motion, perhaps in water, in which they were liable to be struck by other bodies in the same movement: agencies have, no doubt, been at work, both during and since the geological period, of which we are ignorant.

6. A letter from Mr. R. Cull, in the *Athenæum*, No. 1652, who says:—"If geologists indorse the reported opinion of Mr. Prestwich, they will have to show how it is that no osseous remains of mankind are found, while his works of art abound in the drift. It appears easier to believe that these flints are not fashioned by art, than to believe that they *are*, with the antiquarian geological difficulties connected with it."

7. Mr. Evans's reply to Mr. Wright (*Athenæum*, No. 1652), maintaining the flint-implements to be the work of men's hands, from their uniformity of shape, correct outline, and sharp cutting edges and points; adding, that they do not occur in equal abundance throughout the particular formation of drift in which they have been found.

8. A letter from Mr. A. C. Ramsay, contending that these flint-hatchets are as clearly works of art as any Sheffield thwittle, and could not have been produced by the action of running water, or waves on a beach, which remove not give asperities. Their position in the drift is testified by various independent officers, French and English. (See *Athenæum*, No. 1656.)

9. In Dr. Anderson's paper, read to the British Association, the skulls of Amiens and Abbeville, the remains in the caverns of Torquay, and those in Sicily, the flint weapons in veined limestone in Cantire, and the arrow-heads with elephant remains in Suffolk, were successively brought under review—the solution of all these given by Dr. Anderson being, that from the action of petrifying springs the subsidence of tracts of country, the falling-in of the roofs of caverns, the undermining of cliffs and headlands, the superficial soil is incrusted or buried beneath the strata on which it was originally superimposed. He saw no evidence deducible from the superficial drifts to warrant a departure from the usually accepted data of man's very recent introduction upon the earth.

10. Mr. Wickham Flower's "Observations on a flint-implement recently discovered in a bed of gravel at St. Acheul, near Amiens," read to the Geological Society. The slight elevation of the chalk at St. Acheul is composed of water-worn chalk-flints, and is about 10 feet thick; above it is a thin band of sand, surmounted by sandy beds (3 feet 6 in.), and brick-earth (11 feet 0 in.). In the gravel the remains of elephant, horse, and deer have been found, with land and fresh-water shells of recent species. From the gravel Mr. Flower dug out a flint-implement, shaped like a spear-head, at about 18 inches from the face of the pit, and 16 feet from the surface of the ground. Mr. Flower in this communication pointed out evidences to prove that this and many other similar flint-implements obtained from the same gravel were really the result of human manufacture, at a time previous to the deposition of the gravel in its present place. Mr. Flower's visit to St. Acheul was made in company with Messrs. Prestwich, Godwin-Austen, and Mylne, with a view to verify the discoveries made respecting the occurrence of flint-implements in the gravels and peat of the Somme Valley by M. Boucher de Perthes, of Amiens. A large collection of osseous remains and flint-objects from the Grotto di Maccagnone, and others from San Ciro, were exhibited; also specimens of flint-objects from Brixham Cave, the gravel of Amiens, &c., and a series of flint-implements from Arabia, North America, Mexico, &c.

11. Dr. Falconer's paper on some caves near Palermo, showing that water had something to do with forming these flints, is evident by the soil, or "cave-earth" in which they were buried. "Slightly-inclined planes of pliocene deposits" stretch outside towards the sea, upon which the contents of the caves seem to have been emptied to a great extent, and the "bone breccia" still remains.

12. Professor Henslow's letter to the *Athenæum*, No. 1673, describing his visit to the celt-producing brick-pit at Hoxne, Suffolk: he supposed there must have been a manufactory of celts from flints, quarried from the gravel found about

this spot, and that many angular fragments scattered about the pit were drifts from flints employed in the manufactory. Mr. Henslow has no doubt of the Hoxne celts being artificial; but he could not meet with any evidence that inclined him to believe these celts to be coeval with the pleistocene remains obtained from the brick-earth bed.

13. Dr. Ogden's Letter to the *Athenæum*, No. 1671, in which he maintains that these flints do not in form resemble anything which Art had ever been known to make; and their forms he attributes to the protracted chemistry of geology: as he adds:—"Considering how extremely little is known about the original formation of flints,—what solvent brought the silicic acid to its nidus in the chalk,—what obstacle there seized and retained it,—what crystallization it obeyed, sometimes furnishing the most beautiful and delicate impressions, but generally the most uncouth, tuberose forms,—I feel more inclined to think that some flints, when subjected to the dissecting agency of corrosive liquids, under many complex circumstances and during incalculable time, may naturally yield such forms."

14. Mr. Wickham Flower's Letter to the *Times*, Nov. 18, detailing his visit to Amiens and Abbeville, satisfying him of the accuracy of Mr. Prestwich's conclusions, describing the implements as the products of human labour and skill, nearly as sharp and clear as if made yesterday; that portion of the natural surface of the flint which has not been struck off in the manufacture, being much water-worn, as are also the pebbles which are found with them. Now, the sharp edge being retained, denotes that the forces by means of which these things were carried into their present position, were in operation but for a short period; and that the actual condition of the gravel in which they are found, and from which they are fashioned, was due to some former change or changes, by means of which these masses of flint were torn from their chalk matrix. But Mr. Flower is at a loss to account for no trace of human bones or any other work of art being found with these implements, and for several hundreds of them being accumulated in a single gravel-pit.

15. Mr. Evans's Letter to the *Times*, dated Dec. 1st, referring to the discovery of implements at Hoxne in Suffolk, by Mr. John Frere, F.R.S., in 1797, which were precisely similar in form to those found at Amiens. The Suffolk weapons were then considered as implements of war "fabricated and used by a people who had not the use of metals," and Mr. Frere, by the situation in which they were found, was almost tempted to refer them "to a very remote period indeed—even beyond that of the present world." Nor was any doubt then expressed as to their human origin.

16. Mr. Prestwich's Letter to the *Athenæum*, No. 1675, controverting part of the evidence received by Professor Henslow from the workmen at Hoxne, but too lengthy for quotation.

17. A Letter in the *Times*, Dec. 5th, in reply to one of Dec. 1st, as follows:—"There is and has been no question as to the finding of what are called 'celts' in beds of 'drift.' The difference lies between 'real works of art' and broken stones said to be so. They are all in 'drift.' What is 'drift?' The detritus of various stones or other mineralogical formations heaped or swept together by running or rushing waters.

"Some call this an alluvial deposit, some diluvial, and, again, others say there are both diluvial and alluvial deposits. Every geologist is aware that many such sedimentary deposits overlie each other in some places, and even modern experience shows how rapidly mere alluvial accumulations, such as sandbanks, bars, or mud, increase or alter. Those searchers after truth who would give reasons for their faith, and who have studied the works of Hutton, Herschel, Von Buch, Lyell, Murchison, Hugh Miller, M'Causland, Anderson, and many others, are unlikely to be superficial or prejudiced. Had they been so, they would have averted their eyes."

In the *Athenæum*, No. 1675, are fresh notices of Mr. Frere's "flint weapons" found in 1797, which seem to be quite different from Mr. Flower's "cats' tongues" (*langues des chats*) of the Somme Valley.

Those flint weapons, so generally—indeed, indisputably—considered to have been the rude manufacture of uncivilized men, are as similar to the present flint, or stone, or volcanic glass arrow-heads, axes, or knives of savages, as if made by them. What is more natural than that disturbed masses, upheaved by earthquake, or broken down from cliffs by action of water, should occasionally overlie modern, even the most modern, formations?

Mr. Darwin tells us of cliffs in Patagonia full of fossils. Suppose such a cliff-face fallen down over an Indian burying-ground, and a river afterwards diverging from its bed depositing a variety of detritus, or drift, including minerals from the Andes. An observer of nature who "sees sermons in stones," and design in everything, need not dread investigations, nor that they will tend to "upset established opinions" which are correct.

We old folks are satisfied that there is no stronger testimony to the Bible (rightly interpreted) than geological science. Let me ask you to read the first chapter of Genesis by the light of the fourth verse in the second chapter, to bear in mind that the expression "Evening and Morning were," or "There were Evening and Morning in the first (&c.) day" (or period), may mean that the earth rotated on its axis all that undefined time, that we may now be in the period of rest from creation, the seventh, and then compare the best modern geological account of this earth's successive alterations, additions, and improvements, all, every one, directly tending to prepare this world for the abode of man.

How can Bunsen, Horner, Darwin, and others, assign at least 14,000 years as the term of man's existence on earth, while they affect to deny or ignore the great fact which their principal authority, "Manetho," adverts to as a matter of notoriety—namely, a deluge, he and other heathen (so called) authorities only differing as to the period of that great catastrophe?

18. Letter from Mr. J. Wyatt, dated December 9th, to the *Times*, strongly urging the implements to have been worked by man. Some "have attempted to account for the peculiar form of these flints by natural phenomena, by chemical action, by violent action of water, by fracture from sudden change of temperature, by direct igneous action on the silex;" and one writer "attempts to show by fragments taken from his glass manufactory, that when a bubble or other imperfection occurs, there is tendency in glass and silex to split up into forms like the so-called celts." Mr. Wyatt adds: "When either silex or glass is fractured by the processes here described, it presents a sharp edge along the whole side of the fracture, but in these flint implements the edge itself is jagged, and evidently formed by a succession of small fractures or chippings off. In the large ones (the *haches* of M. de Derthes) this working is not carried on to the best or thick end, which I take to be strong evidence of design."

TEMPERATURE OF THE EARTH.

MR. HOPKINS has delivered, at the Royal Institution, a lecture "On the Temperature of the Earth at Different Depths." He noticed the observations made in different parts of Europe, from which it appears that the temperature increases 1 deg. Fahrenheit's thermometer, every additional 60 feet that it approaches nearer the centre of the earth; and alluded to observations made in sinking a shaft at Monkwearmouth to the depth of 2200 feet, and of a still deeper shaft at Dukinfield, near Manchester. Assuming that the temperature continues to increase at the same ratio, geologists conclude that at a depth of about seventy or eighty miles the heat would be equal to 6000 deg., at which the hardest rock would be melted. The object of Mr. Hopkins was to show that such conclusions are erroneous. In the first place, they are founded on the assumption that the lower rocks possess the same power of conducting heat as the sedimentary deposits on which the observations have been made; but supposing the conducting power of these rocks to be greater, then the increase of temperature in descending through them would be in a slower ratio, always supposing that the source of heat was the central portion of the globe. He illustrated this position by comparing the transmission of heat through a thick mass of metal and through a plank of wood, both being exposed to the same temperature. In the former case, owing to the greater rapidity with which the heat is conducted, the external surface, though more removed from the heating source, would be only of the same temperature as the outer surface of the thin plank of wood; and, in penetrating through it, deeper spaces must be traversed to arrive at equal temperatures. Mr. Hopkins has undertaken a series of experiments to ascertain whether the primary crystalline rocks do not, in fact, conduct heat more rapidly than chalk, which he took as representing the conducting property of sedimentary deposits in general. The result of upwards of one hundred experiments was, that the crystalline rocks are much better conductors of heat: and Mr. Hopkins said he was persuaded from those experiments, that the conducting power of the lower rocks exceeds four or five times that of the upper deposits. He came to the conclusion, therefore, from his experiments, that the depth at which all bodies became fluid by heat must be three or four hundred miles, instead of seventy or eighty. The same conclusion could also be arrived at astronomically by the precession of the equinoxes. The periods of the changes of the position of the earth's axis, which occasion the precession of the equinoxes, has been calculated with great care, and those calculations agree exactly with astronomical observations. But the calculations of the effect of the action of the moon's different attraction on the nearer and more distant parts of the earth, which produces that phenomenon, were made on the assumption that the earth is a solid body, and they would not be correct if the interior were fluid, with the exception of so thin a crust as geologists suppose. Assuming, however, the crust of the globe to be three or four hundred miles thick, the fluidity of the remaining portions of the interior would not disturb the calculations of the mathematicians; and the conclusions which they have arrived at would correspond with astronomical observations and with physical experiments. Mr. Hopkins alluded, in conclusion, to objections which have been raised to his hypothesis, but he said he felt assured that all those objections could be satisfactorily answered.

PROFESSOR FORBES ON ICE.

A DISCUSSION on the properties of Ice took place at the late meeting of the British Association, during which Professor Forbes made the following statements:—He agreed with Professor J. Thomson that the phenomenon of regelation is only another phase of that property of ice which renders it viscous or plastic on the great scale; he differs from him as to the explanation, at least when applied to the phenomena of glaciers. Professor Forbes has no wish to deny that in laboratory experiments, where ice is exposed to sudden and excessive changes of pressure, the lowering of the freezing point anticipated by Professor J. Thomson may be really efficient in reaggregating the fractured masses. But the view of the gradual fusion of ice throughout a certain small range of temperature below 32° (as proved by M. Proson from his own and M. Regnault's experiments) appear to him to *necessitate* the phenomenon of regelation without any pressure at all. If 32° be the temperature of ice in the extremity of dissolution or on the point of conversion into water, then a solid block of ice at a thawing temperature has a sensibly lower temperature in its interior than at its surface; a fact which Professor Forbes has verified by observation. Such a block may indeed be conceived to be subdivided by isothermal surfaces, of which the exterior one only can be considered to have a temperature of 32°, the temperature of the nucleus being, say 31° 6′, or perhaps a good deal lower; and the intermediate parts having taken up a portion of latent heat, must have an intermediate temperature. The thickness of this stratum of variable temperature is perhaps not less than an inch, and the ice which composes it has manifestly very different mechanical qualities from the nucleus. It is what mineralogists call *sectile*, that is, easily cut and fashioned by the knife, with small hardness and little fragility. It resembles in this respect cheese or hard brown soap, and may be squeezed and moulded under Bramah's press without splintering, showing the characteristic forms of soft solids treated in the same manner. In this respect it differs importantly from the crystalline nucleus, which is hard and splintering. It is manifest that a glacier during summer is placed in the most favourable circumstances to assume this soft transition state, being exposed for days and months to a hot sun, hot air, and water infiltrating innumerable crevices.

But to return to regelation. Admitting the constitution of a block of thawing ice to be such as has been described, the exterior surface alone is maintained at a temperature of 32°, and it is so exclusively by the sources of heat (air and water) exterior to it. The interior strata of ice next to it are colder than itself. Withdraw the air or water by placing next to it another block of thawing ice in precisely the same conditions with the first, the superficial film of water common to both is placed between two surfaces of slightly colder ice. It consequently falls in temperature by giving part of its latent heat to the interior ice (which it softens more or less), but in doing so it becomes itself frozen. If the data be correct, it is certain that regelation must result from this constitution of ice and water. It is also certain from experiment that ice but little inferior in temperature to 32°, or having taken up part of its latent heat, is sufficiently softened to be moulded under pressure, and to cohere with other similar surfaces without the intervention of water at all, or anything which can be strictly described as regelation. This may be, and probably is, the ordinary condition of the ice of glaciers in summer. Generally speaking, when ice and water remain in contact the tendency of the ice is to thaw, and the tendency of the water is to freeze. If the former predominate very much in quantity, as in the case of a small ice cavity containing water, the water will gradually pass into the state of ice (provided no external heat reaches it by radiation or otherwise), its latent heat going to soften slightly the surrounding mass. If, on the other hand, a small mass of ice float in a cistern of water, it will in time melt, the cold of crystallization tending merely to render the water slightly less mobile.—*Athenæum*, No. 1670.

CAPE

A VALUABLE collection of Fossil remains from triassic strata at the Cape of Good Hope has recently been presented to the British Museum by the Governor, Sir George Grey, K.C.B. It contains some interesting additions to the singular Bidental Reptiles described by Professor Owen in a series of memoirs in the *Geological Transactions*. The new forms have been named by the Professor:—*Ptychognathus declivis*, a sub-genus of Dicynodont saurian, remarkable for the angular contour and declivity of the fore part of the skull,—*Galesaurus planiceps*, a small saurian, with numerous teeth, including canines, having the proportions and relative position of those in the weasel tribe,—*Oudenodon Bainii*, a completely toothless saurian, analogous to the Rhynchosaurus of the New Red Sandstone of Shropshire, with an extinct kind of Gavial.

FOSSIL BIRD AND CETACEAN FROM NEW ZEALAND.

PROFESSOR HUXLEY has described to the Geological Society a Fossil Bird and a Fossil Cetacean from New Zealand. These remains were, the right tarso-metatarsal bone of a member of the Penguin family, allied to *Eudyptes*, but indicating a bird of much larger size than any living species of that genus, larger, indeed, than even the largest *Aptenodytes*, and to which the name of *Palæudyptes antarcticus* was given,—and the left humerus of a small cetacean, more nearly resembling that of the common Porpoise than that of any other member of the order (*Balæna*, *Balænoptera*, *Monodon*, *Delphinus*, *Orca*, *Hyperoodon*) with which the author had been able to compare it. Nevertheless, as there are very marked differences between the fossil humerus and that of *Phocæna*, Professor Huxley named the species *Phocænopsis Mantelli*. Mr. W. Mantell, F.G.S., to whom the author was indebted for the opportunity of examining these bones, stated that the beds whence they were obtained were certainly of Tertiary age, and of much earlier date than the epoch of the *Dinornis*, which he considered to have been contemporaneous with man. The *Palæudyptes* was from an older bed than the [illegible]

Professor Huxley drew attention to the remarkable fact that a genus so closely allied to the Penguins which now inhabit New Zealand, and are entirely confined to the Southern Hemisphere, should have existed at so remote an epoch in the same locality.

PTERASPIS IN LOWER LUDLOW ROCK.

THE President of the Malvern Natural History Field Club, the Rev. W. S. Symonds, announced at the Apperley meeting of the Cotteswold, Malvern, and Warwickshire Field Club, the discovery of that oldest known fossil fish, the Pteraspis, in the Lower Ludlow rock of Leintwardine, near Ludlow.

BEYRICHIA.

BEYRICHIAS have been found by Mr. Robert Jones in specimens sent to him by Professor Dawson, of Canada, from the lower carboniferous beds of Nova Scotia. They have never hitherto been met with in any later formation than the Upper Silurian. Mr. Jones has also seen Beyrichias in the lower carboniferous strata of the border counties of North Britain, in specimens with which he has been favoured by Mr. Tate, of Alnwick. A new genus, allied to Beyrichia, and to be named *Kirkbya*, is represented by one species in the lower carboniferous rocks of Glasgow, and another in the magnesian limestone of Sunderland.

CONICAL FORM OF VOLCANOES.—EVENTS OF ETNA.

SIR CHARLES LYELL, in a paper read by him to the Royal Institution, infers, from two recent excursions to Etna, that the discovery of lava being capable of forming continuous and tabular masses of crystalline rock on steep slopes, often exceeding 30°, enables us henceforth to dispense with that paroxysmal and terminal upheaval, which the advocates of "craters of elevation" legitimately inferred from their premises, for it was as necessary for them, so long as the volcanic beds were assumed to have been originally horizontal, to ascribe the whole elevation to a force acting from below, as it would have been if the uppermost layers of each volcanic mountain could be assumed to be of marine origin. In opposition to such a doctrine, Sir C. Lyell maintains that mechanical force has nowhere played such a dominant part in the Cone-making process as to warrant our applying any other term save that of "cones of eruption" to volcanic mountains in general.

In conclusion, the lecturer gave a brief sketch of the series of geological events which he supposed to have occurred on the site of Etna since the time of the earliest eruptions, events which may have required thousands of centuries for their development. The first eruptions are believed to have been submarine, occurring probably in a bay of the sea, which was gradually converted into land by the outpouring of lava and scoriæ, as well as by a slow and simultaneous upheaval of the whole territory. The basalts, and other igneous products of the Cyclopean Islands, were formed contemporaneously in the same sea, the molluscous fauna of which approached very near to that now inhabiting the Mediterranean; so much so, that about nineteen-twentieths of the fossil species of the sub-Etnean tertiary strata still live in the adjoining seas. Hence, as that part of Etna which is of subaerial origin is newer than such fossils, the age of the mountain is proved to be, geologically speaking, extremely modern. During the period when the volcano was slowly built up, a movement of upheaval was gradually converting tracts of the neighbouring bed of the sea into land, and causing the oldest volcanic and associated sedimentary strata to rise, until they reached eventually a height of 1200 feet (and perhaps more) above the sea-level. At the same time the old coast-line, together with the alluvial deposits of rivers, was upraised, and inland cliffs and terraces formed at successive heights. The remains of elephants, and other quadrupeds, some of extinct species, are found in these old and upraised alluviums. Fossil leaves of terrestrial plants also, such as the laurel, myrtle, and pistachio, of species indigenous to Sicily, have been detected in the oldest subaerial tuffs. At first the cone of Trifoghetto, and probably the lower part of the cone of Mongibello, was built up; still later the cone last-mentioned, becoming the sole centre of activity, overwhelmed the eastern cone, and finally underwent in itself various transformations, including the truncation of its summit, and the formation of the Val del Bove on its eastern flank. Lastly, the phase of lateral eruptions began, which still continues in full vigour.

Mr. G. Poulett Scrope, M.P., F.R.S., has also communicated to the Geological Society a paper "On the mode of formation of Volcanic Cones and Craters." The author refers to Baron Humboldt having in his *Cosmos*, vol. iv., applied the whole weight of his great authority to the support of the theory of upheaval in contradistinction to eruption as the *vera causa* of volcanic cones and craters,—a theory which the author, with Sir Charles Lyell, M. Constant Prévost, and many others, believes to be not merely erroneous, but destructive of all clearness of apprehension as to the character of the subterranean forces, and the part which volcanic action has played in the structural arrangement of the earth's surface.

He showed, by reference to the works of Spallanzani, Dolomieu, Breislak, &c., that the early observers of volcanic rocks and phenomena, together with the unscientific world, looked upon volcanic cones and craters, whether large or small, as the result of volcanic eruptions; but that of late years a new doctrine had been propagated by MM. Humboldt, Von Buch, Elie de Beaumont, and Dufrénoy, which denies altogether that volcanic mountains have been formed by the accumulation of erupted matters, and attributes them solely to a sudden "bubble-shaped swelling-up" of pre-existing horizontal strata,—the bubble sometimes bursting at top and then leaving its broken sides tilted up around a hollow (elevation-crater).

We have not space for the details. In recapitulation, he declares that the characters of all volcanic mountains and rocks are simply and naturally to be accounted for by their eruptive origin, the lavas and fragmentary matters accumulating round the vent in forms determined in great degree by the more or less imperfect fluidity of the former, which, as in the case of some trachytic lavas, glassy or spongy, may and do congeal in domes or bulky masses immediately over, or in thick beds near the vent, or, as in that of some basaltic lavas, may flow over very moderate declivities, to great distances; and consequently that the upheaval- or elevation-crater-theory is a gratuitous assumption, unsupported by direct observation, and contrary to the evidence of facts. He concludes by representing its continued acceptance to be discreditable to science, and an impediment to the progress of sound geology, inasmuch as false ideas of the bubble-like inflation, at one stroke, of such mountains as Etna or Chimborazo must seriously affect all our speculations on Geological Dynamics, and on the nature of the subterranean forces by which other mountain-ranges or continents are formed.

ERUPTION OF THE VOLCANO MAUNA LOA, IN THE ISLAND OF HAWAII.

Mr. W. L. Green has forwarded to the *Edinburgh New Philosophical Journal*, No. 19, an account of this eruption. On Sunday, the 23d January, 1859, the Volcano broke out. The lava ran in a N.N.W. direction, and by the end of the month reached the sea at a place called Palaoa, nearly forty miles from the crater, where it destroyed a small fishing village.

The schooner "Kamoi" sailed from Honolulu with a number of persons on board to visit the neighbourhood of the eruption; and, on her return, an extra edition of *The Pacific Commercial Advertiser* was published, with a map of Hawaii, describing the course of the lava-stream. Copies of this paper have been sent to England by Mr. Green. The spot visited by the excursionists was about ten miles from the mouth of the crater. Mr. Vaudry, an English traveller, had set out to reach the crater itself, and had not returned when the "Kamoi" left the island.

From the distance at which we observed it, about ten miles, the crater *appeared* to be circular, and perhaps 300 feet across. It may prove to be 500 or even 800 feet across. The rim of the crater is surrounded by cones of stones and scoriæ, these cones constantly varying in extent, now growing in size, and again all tumbling down. The lava does not run out from the side of the crater, like water from the side of a bowl, but is thrown up in columns, like the Geyser springs, rockets, or a pyramid, to a height nearly double the base of the crater. If the mouth of this be 500 feet across, the perpendicular height must be 800 to 1000 feet.

The lava runs in a great number of streams, spreading out to five or six miles in width. For the first six miles from the crater the descent is very rapid, the flow of lava varies from four to ten miles an hour. But after it reaches the level plain the stream moves slower.

Another stream is described as rolling over the plain, twenty to twenty-five feet in height, and about an eighth of a mile in width; in fact, a mass or pile of red-hot stone, resembling a pile of coals on fire, borne along by the liquid lava stream underneath. As it moved slowly along, large red-hot boulders would roll down the sides, breaking into a thousand small stones, crushing and burning the trees which lay in the track.

The poor inhabitants of Wainanalii, the name of the village where the fire reached the ocean, were aroused at the midnight hour by the hissing and roaring of the approaching fire, and but just in time to save themselves. The village is, of course, all destroyed, and its pleasant little harbour filled up with lava.

Large boulders of red-hot lava stone, weighing hundreds if not thousands of tons, thrown up with inconceivable power high above the liquid mass, could be seen occasionally falling outside, or on the rim of the crater, tumbling down the cones, and rolling over the precipice, remaining brilliant for a few moments, then becoming cooled and black, were lost among the mass of surrounding lava. Watching it with intense delight, the only drawback being the severe cold of the night. A dense column of smoke is described as continually rising out of the crater, on the north side, in a continuous column, perhaps 10,000 feet high.

The stream which had run into the sea had apparently ceased flowing, and was cooled over, so that we crossed it and re-crossed it in many places, and through the fissures we could see the molten lava with its red-hot glow. An intense heat issued out from them. In many places the surface was so hot that the soles of our shoes would have been burnt had we not kept in rapid motion.

ERUPTION OF VESUVIUS.

In the months of July and August last Vesuvius displayed great activity, and committed much devastation. Professor Palmieri, Director of the Observatory on the mountain, reports that from May 4, the lava had continued to flow almost in the same manner and direction. He says:—

Its continued elevation by successive superimpositions above the level of the Fasso Grande, occasioned frequent overflowings on one side towards the road, and on the other over the cultivated lands in the direction of the "Tironi." The lava always flows out in a secret manner, and proceeds by some subterraneous chambers after the manner of an aqueduct, which have been formed by itself,—and when it is in a large mass it often breaks in some directions the walls of the passage, and bursts forth an unexpected and unusual river of fire in a spot where it has not been seen for a long time. On the evening of the 3rd of August the streams of lava towards the extremity of the current appeared to be almost spent; but on the following evening the stream appeared at a little distance from its source, in a site where it has not been visible for a year, and all supposed that another mouth had been opened here. This new branch of lava followed the direction of the "scorie" of 1819, and moderated the impetus and the vivacity of those on the Rio di Quaglia and the Tironi. The character of this lava, which appeared on the 4th of August, is somewhat different from that of the other streams, even in colour. In the month of June the seismograph signalled four shocks of earthquake, the last of which was on the 29th of the month, and was very strong; but from that day up to the 19th of August no other was marked. The apparatus of variation of Lamont has presented by its inclination the fact of remarkable perturbations by which the scale of the instrument has got beyond the field of the tube, and after some time has returned. The water of the wells in the month of May was greatly diminished. The mass of lava which has issued from the lateral mouth at the foot of the cone, under the enormous congeries which conceals it, may with much probability be estimated at about 36,000,000 of cubic mètres, in a superficies of about two square miles. The altered form of the ground by the enormous masses of hardened lava which have filled up valleys, elevated mountains, and created new "*burroni*" trenches, exposes many estates to great danger from future inundations of fire, but, in my opinion, to no danger from the water, as the "scorie" has a marvellous property of absorbing and retaining rain-water. Before 1855 I saw an impetuous torrent formed by the rains pass just behind the Observatory, By the Fosso della Vetrana, and then fall into another called the Farame, finally running into a channel which had been formed of mason work. After the lava, however, had filled up those great *burroni* (valleys), not one drop of water was seen to run. Vesuvius has often presented the phenomenon of long periods of small eruptions through mouths near the summit of the cone, but this continued flowing of lava for fifteen months through an opening at the base of the cone is a fact perfectly new, as is also new and singular the mode in which the lava bursts out, and flows secretly for upwards of a mile at times, not betraying the source from which it comes even by its smoke. When, however, it is remembered that such an opening near the base of the cone is in direct communication with the lower part of the central axis of the same,—that is, with the regular chimney of the volcano,—the fact will appear new, perhaps, but very natural, and then it will awaken no surprise to see lava coming out without a smoking aperture, because the great cone of Vesuvius at this conjunction gives out smoke at the top and lava at the base. I wish to remark the great abundance of lead I have found in the largest number of sublimations gathered in the smoke-holes of the lava, though the chlorure of lead alone and crystallised has been very rare. Lead was never observed in the lava by those who before me had examined the matter which was collected in the smoke-holes. I found it for the first time in an aperture of the lava in 1855, in the state of chlorure, but in this eruption it forms a part of the greater number of the sublimations, and is almost always mixed with other matter, which is generally chlorure and sulphate. —*Abridged from the Athenæum*, No. 1662, Sept. 3, 1859.

EARTHQUAKE AT QUITO.

The city of Quito, with its numerous monuments of architectural magnificence, has been laid in ruins by a terrific earthquake. From the journal *El Artesano* we learn that "on the 22nd of March, at half-past eight in the morning, after a slight atmospheric detonation, the most violent movements of the earth were felt, in which it was seen that the city had reached its last end.

"The voice of man was hushed in his ordinary affairs, and bitter lamentations and prayers to Heaven ascended in the midst of the quivering earth, the shuddering of mountains, the terrifying reports of the towers and cupolas of the temple, and of the tiles and walls as they fell to the earth. Seventy-four seconds were sufficient to reduce to ruins the proud edifices which the perseverance of man had raised up in the course of many long years.

"There is not an edifice which has not suffered, and many do not admit of repairs unless they are demolished. The Cathedral is mutilated, and the place which was used as an Ecclesiastical Court also lost its roof. The portico of the chapel of El Sagrario lost its best half, and the middle aisle is greatly injured. The temple of the Augustines lost its principal cupola and the tower and angle of its cloister. The temple of the Catalines came to the ground in its main part, which formed the front and the cupola, leaving several persons in its ruins. Of the temple of the Dominicans there fell the balustrades, two angles of the principal court, and one of the second. The tower of the hospital demands immediate demolition, in consequence of the ruinous state in which it has been left. The church of Our Lady del Carmen is greatly injured, the great bars of iron which supported its angles having fallen. The magnificent temple of Santa Clara has been completely damaged, in consequence of the loss of her collateral arches and the destruction of her little cupola. From the temple of La Merced, there fell the high cupola, some convent cells, and the little cupola of the tower, while the clock was striking the fatal hour for the last time. Both towers of the temple of San Francisco were found to be greatly damaged; but this one has suffered the least, although the interior of the convent is greatly damaged. The temple of St. Roque lost its tower, and one of the two temples of St. John the Evangelist lost one of the two which it had. The church of Recoleta de Dominicos is completely ruined.

"The Government palace is completely injured in its two cabinets, as well as the archiepiscopal palace. The colleges and chapels are all left in greater or less ruin. We conclude this faithful account by stating that, although there are a few houses not completely destroyed, there is not a single one which does not demand immediate repair.

"From some accounts which we have received from adjacent places, we learn that the city of Machachi is destroyed, also the towns of the north—Perucho, Pomasqui, and Cotocollao, including the habitations of the fields."

Professor Jameson, a resident in Quito, writes, 23rd March, 1859:—"Since yesterday morning we have been dreadfully alarmed by a violent shock of an earthquake, which has overthrown and ruined many of the public buildings, and damaged more or less *all* the houses of private individuals. The churches have suffered most, but, fortunately, *few* lives were lost. The earthquake (the most severe I ever experienced) commenced yesterday morning at half-past eight, and lasted about a minute. I had just reached my house, and had barely time to station myself in the centre of the court-yard. The movement of the ground resembled a succession of waves, and I found it impossible to remove from the spot I occupied. My house has suffered no further damage than several cracks in the walls, and having the tiles that covered it completely jumbled together, and a number of them thrown down and broken." And as Professor Jameson mentions that comparatively *few lives were lost*, the newspaper account of 5000 of the inhabitants having been killed must be a myth. From Professor Jameson, however, saying that this earthquake has been the most severe he ever experienced, it must indeed have been an appalling one; for he has resided now thirty years continuously in that volcanic region, where these things are of frequent occurrence.

EARTHQUAKE IN CORNWALL.

On the 18th of September, 1859, the shock of an Earthquake was felt at New Quay, Cornwall. The shock lasted for about a minute. On the same day a tremendous gale, which did much damage in London, was severely felt by the shipping in the Channel.

GEOLOGY OF NEW ZEALAND.

DRS. FERDIN and Hochstetter, having devoted six months in New Zealand to investigate its Geology, have communicated the result in a lecture, delivered at Auckland. We quote a few of the leading facts:—

The great volcanoes and active igneous regions of New Zealand are regarded as sacred ground by the natives. The grand volcano of Tongariro is believed to be the backbone and head of the giant ancestor of the New Zealanders, and they do all in their power to prevent the curious traveller profaning, as they deem it, the sacred cone of this mountain.

The first striking characteristic of the Geology of Auckland, according to Dr. Hochstetter, is the absence of the primitive plutonic and metamorphic formations. The oldest rock that he met with belongs to the primary formation. It is of very variable character, sometimes being more argillaceous and of a dark colour, more or less distinctly stratified, like clay-slate; at other times the siliceous element preponderates, and from the admixture of oxide of iron the rock has a red jasper-like appearance. No fossils have hitherto been found in this formation in New Zealand, and therefore it is impossible to state the exact age; it is probable, however, that these argillaceous siliceous rocks correspond to the oldest Silurian strata of Europe. The existence and great area of this formation are of considerable importance, as all the metalliferous veins hitherto discovered in Auckland, or likely to be found, occur in rocks of this formation.

Astronomical and Meteorological Phenomena.

OCCULTATION OF SATURN.

ACCORDING to an observer an Occultation of Saturn was observed at Clifton, on the evening of the 8th of May (lat. 51° 28′ N.; long. 2° 37′) in a cloudless sky. The times of disappearance only of the ring and body of the planet are given, as, being on the dark limb of the moon, they are necessarily more accurately observed than the reappearances. Owing to the angle at which the contact of the ring with the moon's limb took place, the times of contact of the inner edge of the rings could not be seen:—

	Greenwich Mean Time.		
	H.	M.	S.
First contact of ring	8	18	0
First contact of Saturn	Not seen.		
Last contact of Saturn	8	18	36
Last contact of ring	8	18	44

The clock-error was ascertained by an observation of the upper transit of *a* Cassiopeiæ. At the reappearance next day, the last contact only, of the ring at the moon's bright limb, was well seen; it occurred at 9h. 16m. 24s. (g. m. t.), and at a point (roughly) about four-tenths of the illuminated arc of the moon's circumference, from the top on the left hand, as seen in an inverting telescope. In the disappearance of the ring, at the last contact, there appeared to be a sort of unexpected lingering of a spot of light, such as might be caused by a lunar atmosphere.

THE COMET OF 1859.

THIS new Comet was discovered by M. Tempel, at Venice, about the beginning of April, 1859, has been observed at Rome by Father Secchi, and at Paris by M. Y. Von Villarceau. It has been rapidly approaching the sun, and but a few days ago was only about 8,000,000 of leagues from it. Since the 29th of May, however, it has begun to recede at the rate of 2,000,000 of leagues in twenty-four hours, or twenty-four leagues per second, being a velocity at least 200 times greater than that of a cannon-ball. This velocity is, indeed, gradually declining; nevertheless, enough of it remains to carry the comet to a distance of 36,000,000 of leagues from the sun. As to the distances of the comet from the earth, its nearest approach, which occurred on the 24th of April, was to within 26,000,000 of leagues.—*Athenæum*, June 11, 1859.

BIELA'S DOUBLE COMET.

THE French Academy of Sciences has received a communication from M. Faye on the singular phenomenon presented by Biela's Comet, which has actually been split into two parts, each of which is now a separate comet! A case of this kind is recorded by Ephorus, a Greek historian, whose works are lost. This comet appeared, according to M. Humboldt, under the archonate of Asteius, in the fourth year of the 101st Olympiad, two years before the battle of Leuctra, when the two towns of Achaia, mentioned by Seneca, were washed away by the sea in consequence of an earthquake. The separation of Biela's comet in two shows that Ephorus spoke the truth; but the comet of Asteius separated suddenly and rapidly, since the separation was visible to the naked eye, whereas that of Biela's comet has been effected very slowly. The two comets have been moving together for years side by side, so to say, and at so short a distance from each other, that it was for a long time impossible to distinguish one from the other with the naked eye. M. Faye hence concludes that the separation of Asteius's comet was owing to causes different from those operating on Biela's comet.

THE COMET OF DONATI.

We quote the following from Mr. George Bond's account of the great Comet discovered by Donati, June 2, 1858; these details being principally derived from the manuscript records of the Observatory of Harvard College:—

The most recent intelligence leaves no room to doubt that the comet of Donati is periodical, having a time of revolution of about two thousand years. The following are the results arrived at by different computers:—

Watson,	2415 years.	Graham,	1620 years.
Bruhns,	2102 ,,	Brunnow,	2470 ,,
Lowy,	2495 ,,	Newcomb,	1854 ,,

The last two determinations are based upon longer intervals of observation than the others, Mr. Newcomb's being a few days longer than that of Dr. Brünnow. The remaining uncertainty in the period will be materially reduced, when observations have been received from the southern hemisphere, where the comet is still in sight.

The subjoined table contains the distances of the comet from the sun, and from the earth, and its hourly rate of motion:—

1858.		Distance from Sun in miles.		Distance from Earth in miles.		Hourly Velocity in miles.
June 2	...	215,000,000	...	240,000,000	...	65,000
July 2	...	173,000,000	...	240,000,000	...	72,000
Aug. 2	...	127,000,000	...	220,000,000	...	84,000
Sept. 1	...	82,000,000	...	160,000,000	...	105,000
,, 11	...	70,000,000	...	130,000,000	...	115,000
,, 21	...	60,000,000	...	95,000,000	...	124,000
Oct. 1	...	56,000,000	...	66,000,000	...	128,000
,, 11	...	61,000,000	...	52,000,000	...	123,000
,, 21	...	71,000,000	...	67,000,000	...	114,000

Supposing its last perihelion passage to have occurred at the beginning of the Christian era, it must have passed its aphelion in the early part of the tenth century, at a distance of 14,300 millions of miles from the sun, its velocity at that point being 480 miles an hour.

STRUCTURE OF THE TAILS OF COMETS.

THE Rev. E. W. Webb has observed to the Astronomical Society: Though there seems to be no question that the dark space so frequently included in the Tails of great Comets is the result of a hollow structure, an attentive consideratian of the appearances exhibited by the comet of Donati has led me to think it probable that some other cause may concur in its production. The ordinary laws of perspective certainly seem inadequate to its explanation, except in cases in which the darkness bears a large proportion to the brighter streams on each side of it; for, unless the difference is but small between the radius of the hollow interior and that of the whole tail, the sine will not exceed the versed sine in a sufficient ratio to account for so great an increase of luminosity as is frequently witnessed. On the contrary, at one period in the course of Donati's comet, at the end of September and during the first few days of October, the central darkness in the train, though very intense, occupied a comparatively small part of its whole breadth. My own estimate on September 30 gave it but one eighth of the entire width of the tail, in which case a simple calculation will prove that the sine would exceed the versed sine only by something less than one-eighth part, and consequently the resulting difference in brightness would by no means accord with observation. The supposition of a shadow projected from the nucleus might seem at first to assist us with a supplementary amount of darkness; but it will be found unavailing when we have compared the case of the comet of 1811, in which a transparent space surrounded the nucleus alike *on every side*. Hence it may be thought probable that there must be some other cause for this appearance; and I have been induced to conjecture that, admitting the existence of a hollow interior, the difficulty might be met by the additional supposition of a radiated structure, in consequence of which the luminous particles, drawn out into a lengthened form, would in the apparent centre of the tail present their ends only, but on each side of it their full extent, to the observer's eye. At any rate such a conjecture would be fully in accordance with the hypothesis of a polar force of repulsive character, of which there seem to be other evident indications.—*Proceedings of the Astronomical Society*, No. 10.

SOLAR RADIATION.

MR. GLAISHER has described to the Meteorological Society a new arrangement of the thermometer for Solar Radiation, in which the whole tube and bulb of the instrument are enclosed in an outer tube and ball, from which all air is excluded, the bulb being in the centre of the ball which is three inches in diameter. He exhibited a series of simultaneous observations with this new arrangement and one of the former construction, from which it appeared that the results are far more uniform and truthful by the new form, which holds out the hope that by its adoption results at different stations may be rendered comparable.

ATMOSPHERIC OZONE.

Mr. H. S. Eaton has read to the Meteorological Society a paper "On some of the Atmospheric Conditions favourable to the Development of Ozone, as deduced from Observations [illegible] at Little Bridy, Dorset." The author stated that the object of his paper was simply to endeavour to show the close and direct relation which the amount of ozone bears to that of rain and cloud. After describing the position where the observations were taken, and giving some particulars of the locality, Mr. Eaton clearly showed, by means of tables, the relative distribution of ozone, cloud and rain, for each point in the compass, as deduced from the observations taken at Little Bridy, from February 20, 1857, to November 6, 1858. By these it was clearly seen that ozone was prevalent to the largest extent when the direction of the wind was between the south and west points of the compass, and when the amounts of rain and cloud were greatest; and that the least amount of ozone was coincident with winds having a northerly and easterly direction, and with the least amounts of cloud and rain.

REMARKABLE COLD IN CANADA.

Dr. Smallwood has stated to the Meteorological Society that the weather at the beginning of the month (January, 1859) was rather mild, the mean temperature of the first day being 30° 9′. The thermometer fell on the 3rd to —40°, which however did not continue, and a slight fall of snow occurred on the 4th. After entering into some details as to the somewhat extraordinary and varying state of the weather during the intermediate days, he (Dr. Smallwood) said that at 10 P.M. on the 7th, the wind suddenly veered from the north to the west by south, and the mean velocity attained during the night, was 36·22 miles; slight showers of snow occurred until daybreak, and on Saturday, the 8th, at 3 A.M., the thermometer indicated zero; at 6h. A.M., it was at —4° 0′; at noon, —2° 9′; and at midnight, —16° 4′; on the 9th, at 6h. A.M., it was —29° 9′; at 2h. P.M., —21° 5′; and at midnight, —36°; on the 10th, at 6h. A.M., it was —43° 6′; at 9h. A.M., —41° 6′; at 2h. P.M., was —14° 3′; and at midnight, —31° 6′; on the 11th, at 6h. A.M., it was —37° 1′; at 2h. P.M., —19° 9′; and at midnight, —18° 1′; on the 12th, at 6h. A.M., it was —19° 4′; at 2h. P.M., —10° 4′; and at 10h. P.M., —5°; on the 13th, at 6h. A.M., —3° 1′; and at 7h. A.M., it was again at zero; indicating that for a period of 124 hours and 30 minutes the temperature was below zero. Mercury, he goes on to remark, froze in open vessels, and mercury in the tube of the thermometer marked —43° 6′, showing that mercury contracts by temperature below its freezing point as mentioned by Dr. Kane in his Arctic voyages. The Aurora Borealis was visible on the nights of the 9th, 10th, and 11th, but not attended with any great display. Dr. Smallwood then went on to state that this cold term was felt generally throughout Canada and the Eastern States, and would seem to have travelled from the west eastward. At Huntingdon, about sixty miles south of his position, the mercurial thermometer indicated —44°, and mercury was frozen quite hard in fifteen minutes' exposure.

MILD WINTERS.

A PAPER has been communicated to the British Association "On Mild Winters in the British Isles," by Professor Hennessy. He pointed out the circumstance that the meteorological observations made during the late remarkably mild winter tended to confirm the law which he had already announced in a letter to General Sabine, which appears in the *Proceedings of the Royal Society* for 1858. This law is, that during mild winters the coast stations exhibit an increase of temperature more than inland stations, and that the temperature on the west and south coasts approaches towards uniformity. In France, as pointed out by M. Liais, the first part of this law is found to hold good, as evinced in the comparative climatology of Cherbourg and Paris. Mr. Hennessy referred these phenomena to an abnormal extension of heat-bearing currents across the Atlantic. From the greater stability of such currents than those of the atmosphere, and from the important influence they undoubtedly exercise upon our climate, he is led to infer that we are rapidly approaching a period when it may become possible to foretell whether the winter shall be cold or warm by knowing the conditions of temperature and the movements of currents in the Gulf of Mexico and the Atlantic during the summer and autumn.

ANNUAL VARIATION OF THE BAROMETER.

A PAPER has been read to the British Association "On the Annual Variation of the Barometer," by Mr. A. Brown. It has been stated by Professor Dove, and the truth of the assertion has been admitted by some of the leading meteorologists in England, that when the tension of vapour in the atmosphere is subducted from the whole atmospheric pressure (for each hour of the day), the remaining diurnal variation of the pressure of *dry air* has a period of twenty-four hours, the maximum of the morning disappearing. This resolution of the barometric fluctuations into two oscillations, each of which has a single maximum and a single minimum in the course of the day, coinciding nearly with the epochs of greatest and least temperature. This conducted its author to a very simple explanation of the whole phenomenon. The object of Mr. Brown's communication is to point out the insufficiency of this explanation. This is stated to appear from a discussion of the observations made at Trevandrum, in India, and at a neighbouring station in close vicinity to the sea, from the observations at Makerstoun, in Scotland, and from the observations of Nertschinck, in Siberia. Mr. Brown concludes his paper by proposing a very different explanation of the barometric oscillation, in which it is ascribed to the inducing action of the sun (magnetic or electric) upon the earth's atmosphere.

OF RAIN.

IN the quarterly return of the Registrar-General ending with June, it is stated that "the Deficiency in the Fall of Rain from the beginning of the year is 1¾ inch. The deficiency in the years 1854, 1855, 1856, 1857, and 1858, amounted to the average fall of one year—viz., 25 inches." In all countries traces of dried-up streams are met with; but within the historical period there are few or no examples of new rivers coming into existence. The Dnieper at Kiev is drying up. The redoubted plains of Troy can with difficulty be recognised or traced, because the rivers mentioned by Homer, whose descriptive topography is not doubted, either cannot be found, or they are now such insignificant streams as to fall far below the descriptions of the poet. About the mouths of the Nile the water is becoming shallower; while there is reason to believe that the volume of its waters has been within the period of history sensibly diminished. The Baltic is decreasing. The Adriatic derives its name from a town that is now eighteen miles from the shore, and was once a flourishing sea-port. North America is sensibly draining. The rivers are slowly wearing away the rock, and occupying a lower bed. America on the Pacific Ocean is notoriously rising, or the ocean which surrounds it is sinking.[*]

UNUSUAL FALL OF RAIN IN THE LAKE DISTRICT IN JANUARY, 1859.

DR. DAVY has communicated to the Royal Society the following:—

Whilst the average fall of rain during the preceding six years in January has been at Ambleside 4·22 inches, in January, 1859, the rain measured amounted to 14·82 inches.

The quantity of rain that fell in other localities of the district during the same month is stated in a table, in which also is included the rain-fall in some other parts of the United Kingdom. In the former, it has ranged from 14·375 to 6·514 inches, diminishing with distance from the central mountains; in the latter, the range has been from 6·48 inches to 0·36 inch, diminishing, it would seem, with distance from the western coasts.

In another table some other instances of extraordinary rain-falls are given which occurred in the lake district at Coniston and Ambleside, varying from 12 to 24·39 inches in a month.

A third table is appended, showing the quantity of rain monthly that has fallen at Southwaite, in Borrowdale, during fourteen years; from which it appears, that the maximum fall monthly has been 32·83 inches, and yearly 160·55 inches. In connexion with the rain-fall, other meteorological observations are offered, illustrative of the peculiarities of 1858, and of the spring of 1859; of which, as regards the last, the most remarkable are a prevalence of westerly winds, exceeding mildness, and a precarious spring; vegetation in the first week in March being at least a month in advance.

THE ROYAL OBSERVATORY.

ON June 4, the Astronomer Royal, accompanied by the President f the Royal Society—who by virtue of his office is Chairman of he Board of Visitors—and a numerous assemblage of eminent scientific men, explained the various alterations, additions to the instruments, and present condition of this great national establishment.

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[*] See some able observations upon this subject in the *Illustrated London News*.

By far the most important event—according to the Astronomer Royal's official Report to the Visitors—during the past year has been the erection of the New South-east Equatoreal,—which, although not yet in a complete working state, is sufficiently finished to show that it will be, in all probability, the finest telescope of its nature in the world. The want of a powerful equatoreal has long been felt at the Observatory, and Mr. Airy has naturally been solicitous to supply this deficiency. The experience that the Astronomer Royal has had in the erection of the large equatoreals at Liverpool and at Cambridge has led him to adopt the old English, or Shuckburgh, form of construction, in preference to the long polar axis with telescope on one side, or the German form. He has been the more particular with respect to the mounting of the instrument, as he has never lost sight of the consideration, that in observatories like that at Greenwich an equatoreal cannot be considered as a mere commodious support for a gazing telescope, but must be regarded as a firm, graduated instrument, with which right ascensions and polar distances can be determined with considerable accuracy. Remarking, then, the diameters of the graduated circles, but still more the diameters of the racked circles and the clamped circles, on which the steadiness of clock movement or the firmness of clamps must depend,—remarking also the engineering objections, as regards weakness and friction, to the support of an instrument which projects beyond its two bearings,—Mr. Airy prefers the English form, which he has adopted with no novelty of principle, except that the declination axis is so advanced in front of the centre of the polar axis, and the upper part of the polar frame is so cut away, that the telescope commands the meridian without interruption to, and a little way beyond, the pole. Each cheek of the polar axis is a skeleton prism; and this form is braced against torsion if each of its sides is braced. The bracing is effected by a series of diagonal tension bars, and transversal thrusting bars (each being drawn or thrust by its appropriate screw motion), the long pillars and the bars being of wrought-iron. The upper and lower ovals which carry these are of cast-iron. On the spindle of the lower oval turns freely the hour-wheel, 6 feet in diameter, on which the clock-movement acts. Microscopes are employed to observe the graduations of the circles. The communication of time is made by a small clock with a 10-inch pendulum beating seconds, near the fixed microscope of the hour-circle, and by a galvanic chronometer carried by the eye-end of the telescope; but these clocks do not give independent times: the wire of a galvanic battery, whose circuit is completed at 59" of every minute of the transit-clock, is carried through a coil into which springs a bar-magnet carried by the 10-inch pendulum, and is also carried through the coils of the galvanic chronometer, and thus the 10-inch clock is regulated and the chronometer is moved in exact accordance with the transit-clock. The seconds-wheel of the chronometer has only

59 teeth, and the seconds-dial has only 59 divisions, one of which counts for the two successive seconds (28 and 29); this is necessary in consequence of the loss of one current per minute in the transit-clock, as before remarked. In the 10-inch clock there is no such anomaly.

Another pair of galvanic wires is brought by insulated rings and springs to a touch-piece at the eye-end of the telescope; these wires are connected with the pricker of the chronographic barrel, so that times may be registered on the same sheets as the times of observations with the transit circle and the altazimuth.

The clock movement of the hour-circle is effected by extremely beautiful mechanism. By water falling 25 feet through a tube, a reaction machine (Barker's Mill) is made to revolve four times in a second. This, acting through two worms, drives the hour-circle. For its regulation it gives motion to an axis revolving in 2", which acts upon a conical pendulum (carried by two pairs of springs that do the duty of a universal joint), by the remarkable contrivance called Sieman's Chronometric Governor, of which the effect is that, if there is a tendency to acceleration, the throttle-valve of the water-pipe is immediately contracted. It is necessary that the pendulum suffer a retarding force, which ought to be strictly tangential; to effect this Mr. Airy has so connected a small spade with the rotatory apparatus, that the pendulum, by enlarging its cone, dips the spade into a trough of water. The motion of this apparatus is extremely smooth and uniform.

The Astronomical instruments and the Galvanic apparatus are stated to be in good working order. With respect to the Magnetical instruments, the vertical-force magnet, which rocks on knife-edges, has not performed satisfactorily during the late winter. The daily magnetic curve has been gradually assuming a form approaching much more nearly to a straight line than it had usually given, and, in particular, wanting altogether the remarkable sharp bends at certain hours of the day, which we know to be characteristic of the vertical force. The knife-edges have now been re-ground and polished, and the agate planes, which on examination were found to be far from correct, re-adjusted, and when the instrument was re-mounted, the magnet again presented curves of the well-known form. Mr. Airy states that there is no difficulty in fixing precisely on the time when the indications began to be faulty.

The Meteorological instruments are in good working order. In the radiation thermometer a decided improvement has been made by inclosing its bulb in an exhausted glass globe.

The mean westerly magnetic declination for 1858 is about 21° 29′ 30″, having gradually diminished about 5′ in the year. The mean dip with large needles is 68° 26′·3, and with small needles 68° 20′·7; the change from 1857 (as inferred from observation with the same needle) is insignificant. The vane of Osler's Anemometer has turned 25 times in the year, in the direction N.E., S.W., N.

The maintenance of regular meridional observations is considered, as heretofore, the most important duty of the Observatory. The large Clock-Star Catalogue of 198 stars is thoroughly observed (if possible) every year. There are likewise stars which have been observed with the moon or in occultations, or stars which have some peculiar claims for observation. Of moveable bodies, the moon never passes unobserved, if visible; the sun and all the planets are observed when they pass before 15^h, except on Sundays; and when the moon passes after 15^h, any large planets passing after 15^h are observed. For transits the chronographic method is used, except for close circumpolar stars. The number of meridional observations, from the 22nd of May, 1858, to the 16th of May, 1859, inclusive, is as follows:—Transits (two limbs, or two different systems of wires, being counted as two), 5215; pairs of observations of the collimators by the transit-circle, 305; observations of transit-wires by reflection, 350; observations of collimator by collimator, 52; circle observations of all kinds, 5141; observations of wire by reflection (included in the tale of circle observations), 324. No alteration is made in the system of adjustments.

The important labour of comparing chronometers has gone on as usual during the past year. The new chronometer-oven has been in perpetual use,—and numerous faults of adjustment, which had escaped the notice of chronometer-makers, have been detected in chronometers. The Post-Office clocks are duly regulated; and the time-ball at Deal is dropped by direct current, as formerly.

The Astronomer Royal, impressed with the importance of enabling ships departing from England on long voyages to have the true time at the latest moment, has contrived galvanic signals, which he has proposed to the Lords of the Admiralty should be exhibited every hour at the Start Point. A model of the apparatus was exhibited and explained by Mr. Airy.

In the autumn of 1858 a grant from Government enabled a new work to be commenced at the Observatory. This is a comparison of *Hansen's Tables* with the Greenwich observations of late years, both meridional and extra-meridional. The same observations had, in the daily routine of the Observatory, been compared with the *Nautical Almanack* or *Burckhardt's Tables*. The result, says Mr. Airy, for one year (1852), which alone has reached him, is most remarkable, and he states that *Hansen's Tables* must be regarded as nearly perfect. So great a step, he adds, to the best of his knowledge, has never been made in numerical physical theory.

Under the head of General Remarks, Mr. Airy states that, with the inauguration of the New Equatoreal, will terminate the entire change from the old state of the Observatory. There is not now a single person employed, or instrument used in the Observatory which was there in Mr. Pond's time, nor a single room in the Observatory which is used as it was used then.—*Abridged from the Athenæum*, No. 1650.

METEOROLOGY OF 1859.

Results deduced from the Meteorological Register kept at the Royal Observatory, Greenwich, during the year 1859.

Months.	Mean Reading of Barom.	Mean Tension of Vapour.	Mean Pressure of Dry Air.	Temperature of Air.							Temperature of				Rain.		Weight of Vapour in cubic ft. of Air.	Mean additional Weight required to saturate a cubic foot of Air.	Mean Degree of Humidity. Saturation = 100.	Mean Weight of a cubic foot of Air.
				Mean for Month.	Highest by Day.	Lowest by Night.	Mean of all the Highest.	Mean of all the Lowest.	Range in Month.	Mean Daily Range.	Evap.	Evap. below Air.	Dew Point.	Dew Point below Air.	No. of Days.	Amount in Inches.				
	In.	In.	In.	°	°	°	°	°	°	°	°	°	°	°		In.	Gr.	Gr.		Grs.
Jan.......	30·037	·220	29·817	40·4	53·0	28·5	45·5	35·5	24·5	10·0	38·9	1·5	37·1	3·3	10	0·8	2·6	0·4	86	557
Feb.......	29·823	·225	29·598	43·1	59·0	30·5	50·4	36·3	28·5	14·1	40·6	2·5	37·7	5·4	12	0·9	2·6	0·6	81	550
March..	29·806	·247	29·559	46·4	63·5	28·9	54·2	40·5	34·6	13·7	43·4	3·0	40·1	6·3	10	1·3	2·8	0·8	79	546
April....	29·614	·237	29·377	46·6	79·0	25·3	56·9	39·1	53·7	17·8	43·4	3·2	39·8	6·8	13	2·2	2·8	0·8	78	542
May......	29·789	·312	29·477	53·1	77·0	33·1	64·9	43·9	43·9	21·0	49·6	3·5	46·1	7·0	9	2·4	3·6	0·9	77	539
June ...	29·766	·415	29·351	61·4	81·3	43·5	73·9	53·0	37·8	20·9	57·3	4·1	53·8	7·6	8	1·4	4·6	1·5	77	528
July ...	29·937	·487	29·450	68·1	93·0	46·5	81·8	57·2	46·5	24·6	62·6	5·5	58·3	9·8	7	3·3	5·4	2·1	70	524
Aug......	29·818	·421	29·397	63·5	91·3	46·5	76·1	54·3	44·8	21·8	58·4	5·1	54·2	9·3	11	1·1	4·7	1·8	72	527
Sept. ...	29·709	·361	29·348	56·7	76·0	41·5	67·1	49·0	34·5	18·1	52·7	4·0	50·0	6·7	17	3·8	3·9	1·2	75	532
Oct.......	29·523	·334	29·189	50·9	81·0	26·5	59·0	45·0	54·5	14·0	49·4	1·5	47·9	3·0	18	3·6	3·7	0·4	89	535
Nov.......	29·824	·231	29·593	42·1	60·4	25·5	49·4	35·5	34·9	13·9	40·4	1·7	38·3	3·8	13	2·9	2·6	0·5	87	551
Dec.......	29·623	·191	29·432	36·8	56·5	14·0	41·5	31·8	42·5	9·7	35·4	1·4	33·4	3·4	17	2·2	2·2	0·4	86	553
Means...	29·772	·307	29·465	50·8	72·6	32·5	60·1	43·5	40·1	16·6	47·7	3·1	44·7	6·1	145 Sum	25·9 Sum	3·5	0·9	80	540

EXPLANATION.

The cistern of the barometer is about 159 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of Mr. Glaisher's corrections, as published in the *Philosophical Transactions*, Part I., 1848; and from the readings of the dry and wet bulb thermometers, thus corrected, the several hygrometrical deductions in columns 8, 15, 18, 19, 20, and 21, are calculated by means of Mr. Glaisher's Hygrometrical Tables. *Second Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of the column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in column 3 show the length of a column of mercury balanced by the water alone; and the numbers in column 4 show the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been, had no water been mixed with the air.

[*Concluded on next page.*

The reading of the barometer was above its average value in January, February, March, May, July, August, and November; and in defect in the remaining months of the year.

The mean reading of the barometer for the year, at the height of 160 feet above the mean level of the sea, was 29·772 inches.

The mean temperature of the air was above the average value of 88 years in January by 4½°; February, by 5°; March, by 5¼°; April, by ¾°; May, by ½°; June, by 3½°; July, by 6¾°; August, by 2¾°; September, by ½°; October, by 1°; and below in November, by ½°; and in December, by 2°.

The mean temperature of the air for the year was 50·8°; that of evaporation was 47·7°; and that of the dew-point 44·7°. The mean degree of humidity was 80°, complete saturation being represented by 100. Rain fell on 145 days; the amount collected was 25·9 inches.

Till the 9th of January the temperature was alternately in excess and defect; the mean for the period was nearly that of the average. On the 10th of January a warm period set in, which continued till April 11th, with the exception of the three days ending April 1st, which were 8°, 9°, and 6° respectively below their average values. The average daily excess of temperature for the 91 days ending April 11th was 5½°; on April 12th a cold period set in and continued till May 23rd; the average daily defect was 2½° nearly; and from May 24th to the end of the quarter it was almost always warm; the average daily excess was nearly 3°. From the beginning of July till the 27th of August the weather was unusually fine and hot; the heat during some parts of July was excessive. From August 28th to September 22nd a cold period prevailed, the defect averaging 1½° daily; and from September 23rd to the end of the quarter the temperature was daily in excess to the average amount of 4½°. October was fine till the 20th; the excess of daily temperature was 6°. On the 21st a sudden and severe cold set in; the daily average depression of temperature was 8½°. Till the 8th of November it was warm; on the 9th a cold period set in, which continued, with the exception of two or three days, till December 23rd. It was particularly cold from December 16th to December 19th; from December 24th the weather was warm; the range of temperature in the months of April, October, and December, were unusually large. The range of temperature in October at some places approximated to 60°, and in December the temperature fell as low as zero at some places in the midland counties.

The month of July was warm throughout; the temperature of the air in the shade reached 92½° on the 12th, and 93° on the 13th and 18th; the mean temperature of these days was 75·7°, 75·2°, and 74·3° respectively; and on seven other days in the month the mean temperature of the twenty-four hours exceeded 70°. In the years 1826 and 1837 the mean temperature exceeded 70° on nine days; but back to the year 1814 there is no instance of ten days in the month of July of such high temperature. It sometimes happens that several years together pass, as in the years 1838, 1839, 1840, 1841, and 1842, without any instance of a mean temperature for the day reaching 70°, and there was only one in each of the three following years, 1842, 1843, and 1844. The mean temperature of the month, as might be expected from the preceding facts, was remarkable; it was 68·1°, whilst its average, found from eighty-eight years' consecutive observation, is 61·4°; the excess of temperature, therefore, for the whole month, was no less than 6·7°. The temperature of this month is very remarkable in another respect: the highest monthly temperature in any month in the eighty-eight preceding years was 67° in the year 1778, and the temperature of this month exceeds this 1·1°, and therefore the temperature of July stands out as the highest monthly temperature ever experienced as far back as trustworthy records extend.

The mean high day temperature of July was 81·8°, exceeding its average by 8½°. In the year 1831 it was 76·6°; 1846 was 77·9°; 1847 was 80·6°; and in 1852 it was 77·8°. The high day temperatures were therefore remarkably high.

The mean low night temperature was 57·2°, being 4·1° above the average. The nights were therefore warm, but the high temperature of the month was mostly attributable to excess of day temperature.

The temperature of the year 1859 was nearly 2½° above the average value of eighty-eight years. The highest temperature of the year was 93·0° in July; the lowest was 14° in December; but, as has been before stated, that at some places the temperature descended to zero; therefore the range of temperature exceeded 93°.

The mean weight of a cubic foot of air was 557 grains in January, and 524 in July; and the average for the year was 540 grains.

Thunderstorms were prevalent in May and June.

Obituary.

LIST OF PERSONS EMINENT IN SCIENCE OR ART. 1859.

The Rev. James Inman, mathematician.

Manuel Johnson, Radcliffe Observer, the successor of Mr. Rigaud. Mr. Johnson was a devoted and disinterested worker: nothing was allowed to interfere with the regular duties of the Observatory. Night after night, with not more than a rare periodical break of a week or two, he was at the same task, steadily travelling through the region which he had marked out for his observation of the circumpolar heavens, to which latterly were added the important labours connected with the heliometer. Taking the Groombridge Catalogue as his foundation, he re-observed all the stars—more than 4000—included in that catalogue, and added 1500 other stars not found in Groombridge. The meridian instruments of the Radcliffe Observatory were for several years almost wholly employed for this work; and volumes 40—53 of the Radcliffe Observatory are filled with observations and special catalogues, all designed for ultimate collection into one large catalogue of circumpolar stars, of which some sheets have already passed through the press.

Henry Hallam, the historian. "Hallam was a very competent mathematician, in every matter which could concern an historian of the Middle Ages, up to the middle of the seventeenth century at least. Hallam is as correct in his [illegible] notices of algebra as in any part of his work. He had studied some old books, and all the historians. And the same may be said of Physics as of Mathematics."—*De Morgan.*

E. G. Wright, of Hereford, a good chemist, who first proposed the employment of fulminating mercury in the percussion-cap.

James Flanagan, long attached to the Ordnance Survey of Ireland, and fossil collector to the Geological Survey. He was the discoverer of the Oldhamia of the Cambrian rocks, of the Kiltorcan hill fossils in the upper part of the Old Red Sandstone, and of many other fossils rare or new to science.

Charles Robert Leslie, R.A. "He ranks with West, Newton, and Allston, as one of the four American painters who have earned an English fame. As the illustrator of Shakspeare, Don Quixote, Molière, and Goldsmith, he ranks above them all."—*Athenæum.*

Alexander Humboldt, in his 90th year. It would be impossible within our limit, to sketch even the outline of the important labours of this earnest cultivator of science. The *Athenæum*, No. 1649, states:—"During his Asiatic Expedition, Alexander Humboldt determined many most important facts in connexion with the laws of terrestrial magnetism: and to his energy is due the establishment of magnetic observatories by the governments of Prussia, Austria, Russia, France, America and England, in every part of the world. Connected with these magnetic observatories meteorological registers were carefully kept, and the result has been the determination of the laws which regulate the distribution of heat over the earth's surface—these registers having been, with enormous labour, reduced by Professor Dove, of Berlin. The magnetic observations being all submitted to General Sabine, he has, with the utmost precision, determined the laws regulating the variation of the earth's magnetic intensity, and shown how intimately these variations are connected with temperature, and with great phenomena taking place in that far distant luminary—the Sun itself. In French and German Humboldt published books and papers on several other subjects. His *Astronomical Observations*, his *Essay on the Geographical Distribution of Plants*, and *On the Distribution of Heat on the Globe*, together with his works *On Electrical Fishes*, his *Political Essay on the Island of Cuba*, *Fragments of Asiatic Geology and Climatology*, are well known. But to the public generally, Humboldt is more especially known as the great explorer of the district drained by the Amazon and the Orinoco,—by his *Aspects of Nature*, and by his *Cosmos*." An excellent portrait of Humboldt, from that by Von C. Begas, with a memoir of his life and labours, appeared in the *Year-Book of Facts*, 1848.

David Cox, the eminent landscape painter in water-colours.

JACOB BELL, chemist, founder of the Pharmaceutical Society.

W. R. HAMILTON, formerly President of the Geographical Society. His great feat was the capture from the French of the Rosetta Stone, now in the British Museum.

SIR GEORGE STAUNTON, the celebrated Chinese scholar.

ARTHUR HENFREY, F.R.S. and F.L.S., Professor of Botany in King's College, London, and Examiner in Natural Science to the Royal Military Academy. "Professor Henfrey has long been known as an excellent histologist and sound vegetable physiologist. Especially conversant with the botanical literature of the Germans, we owe to his pen many valuable dissertations upon subjects little attended to in England. The papers in the *Micrographic Dictionary* were written by him in conjunction with Dr. Griffith."—*Athenæum*.

CARL RITTER, the eminent geographer.

THOMAS HORSFIELD, naturalist.

D. S. R. J. RIGAUD, astronomer.

WILLIAM JOHN BRODERIP, naturalist.

EARL DE GREY, President of the Institute of British Architects.

JAMES WARD, the Paul Potter of the English School, and the oldest of the Royal Academicians—in his 91st year.

WILLIAM SPALDING, Professor of Logic in the University of St. Andrew's.

DR. GEORGE WILSON, the biographer of Reid and Cavendish; the First Regius Professor of Technology in the University of Edinburgh, and Director of the Industrial Museum of that city. Dr. Wilson had written an *Elementary Treatise on Chemistry*, *Researches in Colour-Blindness*, and *The Five* [illegible]

ENRY ROLFE, of Sandwich, a sound antiquary.

DR. BRIGHT, the eminent physician, whose great reputation as a pathologist depended on his having been the first to demonstrate the existence of a peculiar condition of the renal organs, constituting a disease which has been named after its discoverer, *Morbus Brightii*.

D. W. MITCHELL, B.A., Secretary to the Zoological Society, and the successful manager of the Gardens for 12 years, the annual number of visitors increasing from 94,000 to 400,000. Under his management, the average income of the Society was more than doubled. The collection of living animals is the finest in the world, and contains more species than all the Zoological Gardens on the Continent can produce. The Reptile House, the Aquarium, and many other improvements, were entire novelties to the public, and many sections of the collection were altogether unrepresented before his time. The Antelopes, the Cranes, and the Himalayan Pheasants are instances of this. The Eland has been perfectly acclimated in England. The Council, in their Report to the Society, acknowledge the eminent services of Mr. Mitchell, upon his resignation of his office, to join the Société d'Acclimatation, in the Bois de Bontagne; he died shortly afterwards at Paris.

SIR THOMAS TASSELL GRANT, a man of high merit as a practical inventor. To his genius the public is indebted for the steam-machinery used in the manufacture of biscuit, which effects a saving to the country amounting annually to 30,000*l*.,—a new life-buoy,—a feathering paddle-wheel,—the patent fuel which bore his name,—and the apparatus for distilling fresh water from the sea.—*Athenæum*.

DR. NICHOL, Professor of Astronomy in the University of Glasgow, and deservedly known for his sound and eloquent books on Astronomy—such as *The Architecture of the Heavens*, *The Solar System*, *The Planetary Systems*, &c.

DR. DYONISIUS LARDNER, the best popular scientific writer and encyclopædist in the English language. He was born in Dublin, in 1793, and educated at Trinity College, Cambridge, where he gained sixteen prizes in metaphysics, pure mathematics, natural philosophy, astronomy, and moral philosophy. Between 1817 and 1827 he published three treatises on geometry, trigonometry, and the differential and integral calculus; in addition to the first six books of Euclid, with a commentary, followed by a treatise on solid geometry. Next appeared his popular *Treatise on the Steam-Engine*, the late editions of which contain the refutation of those absurd reports which have been generally circulated, imputing to Dr. Lardner opinions as to the impossibility of the Atlantic voyage, which are precisely the reverse of those he really expressed. For his *Cabinet Cyclopædia*, 133 volumes, he wrote several treatises, besides obtaining the contributions of leading men of science. Between 1830 and 1840, he was much engaged by railway companies in the scientific and engineering departments. Between 1840 and 1845, he lectured in every principal town of the United States, and in Cuba: of his lectures in two large volumes more than fifteen editions have been sold. His *Handbooks of Natural Philosophy* and *Museum of Science and Art* are deservedly popular, the publication of the latter starting with nearly 40,000 subscribers. In the preparation of his voluminous works, Dr. Lardner was ever mindful of the assistance he received; and he has gratefully acknowledged the service of the many volumes of the *Arcana of Science* and *Year-Book of Facts* as records of current science. The most copious memoir of Dr. Lardner will be found in *Men of the Time*, edit. 1857.

Kingdom Brunel, railway engineer and architect of the

Iron Steam-ship. "Following in the footsteps of his distinguished parent, Sir Isambard Brunel, his early career, even from its

very

onward, and ultimately embraced a wide district of the country. The feeling induced, in steam navigation, the successive construction of the *Great Western* steamer, the largest vessel of the time, until superseded by the *Great Britain*, which was in its turn eclipsed by the *Great Eastern*, the most gigantic experiment of the age. The great ship was Brunel's peculiar child; he applied himself to it in a manner which could not fail to command respect; and if he did not live to see its final and successful completion, he saw enough, in his later hours, to sustain him in the belief that his idea would ultimately become a triumphant reality."—*Address of the President of the Institution of Civil Engineers.*

Robert Stephenson, railway engineer, architect of the Britannia and Victoria Tubular Bridges. "Like Brunel, Robert Stephenson commenced his professional career under his father, George Stephenson. His early years were devoted to the improvement and construction of the locomotive, and to him we owe the type of those machines, many of which are now actually in use on our railways. From the time of the Liverpool and Manchester Railway —when our joint report contributed in a great degree to the adoption of the locomotive engine as the means of transport—and of the subsequent London and Birmingham line, with its long Parliamentary contests, its Kilsby tunnel, and other difficulties inherent in so new an undertaking, a multitude of other lines followed, in which there had to be foreseen and provided for numerous difficulties, all of which were met and surmounted with coolness and consummate skill. Among these great works may be mentioned the Royal Border and high-level bridges, and more especially the Conway and Britannia bridges, which were the first examples on so vast a scale of the tubular principle, and the bridges across the St. Lawrence and the Nile, remarkable alike for their grandeur of conception and successful execution. In the enjoyment of a distinguished name and reputation, Robert Stephenson, like Brunel, has been cut off while still in the middle period of life, and although he pursued his profession with persevering energy, and accomplished in it those triumphs of the successful application of a mind well trained and stored with practical and theoretical knowledge of various kinds, and achieved some of the greatest works of art which have been witnessed in our day, he at the time obtained an eminence in the scientific world rarely reached by al professional man."—*Address of the President of the Institution* gineers. A Portrait and Memoir of Robert Stephenson will be d in the *Year-Book of Facts*, 1851.

Dr. Thomas Nuttal, who devoted much of his time to the study of botany and geology, published the *Genera of North American Plants*, *The Birds of the United States*, and other works. He travelled in California, and published several papers on the shells and plants of that region.

Frederick Crace, whose skill and taste as a decorator had long been acknowledged. He left a valuable and extensive collection of maps, plans, and views of every part of London, from a very early period to the present.

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⁂ Erratum in *Year-Book of Facts*, 1859, p. 13: the cheque presented to Mr. C. Manby, F.R.S., by the Institution of Civil Engineers was for 2000*l*.—not 200*l*., as erroneously stated in the above page.

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